SCIENCE ABSTRACTS.

Section A.—PHYSICS.

NOVEMBER, 1927.

GENERAL PHYSICS.

2793. *Recording Hydrostatic Balance of Simple Design.* **F. G. Tryhorn and W. F. Wyatt.** (Faraday Soc., Trans. 23. pp. 238–242, May, 1927.)—The weight of vapour taken up by a specimen of absorbing material on one arm of an ordinary balance is counterbalanced by the movement in a suitable liquid of a glass cylinder attached to the other arm of the balance. This movement is communicated to a sensitised revolving drum by a spot of light reflected by a mirror attached to the balance arm. The apparatus is thus automatic and continuously self-recording. It may be used for the measurement of adsorption power, velocity of adsorption, and diffusion coefficients. [See Abstract 736 (1925).] L. M. C.

2794. *A Torsion Anemometer.* **J. P. Rees.** (Journ. Sci. Instruments, 4. pp. 311–313, July, 1927.)—An account is given of a new instrument for measuring horizontal air velocities up to 3 feet per second. This instrument has been produced for the Committee on the Control of Atmospheric Conditions in Hot and Deep Mines, particularly for use in such mines where the physiological aspect of ventilation is important. The air velocity is measured by measuring the torsion necessary to keep a vane vertical in the air current, the vane being suspended by means of the wire to which the torsion is applied. AUTHOR.

2795. *Simple Apparatus for Demonstrating Directly the Acceleration of Gravity.* **D. A. Wells.** (Journ. Sci. Instruments, 4. pp. 324–325, July, 1927.)—This paper describes a simple apparatus by means of which the acceleration of gravity can be easily demonstrated. Distances travelled by a falling body during successive time units can be projected directly on to a screen. The apparatus is essentially an arrangement for projecting light from a falling drop of water, the light being interrupted at a constant frequency by revolving sectors. With a sufficiently steady flow of drops, and with the revolving sectors and the time of fall of drops properly synchronised, it should be possible to make fairly accurate determinations of *g*. For demonstration purposes there is no necessity for accurately synchronising revolving sectors and drops. A. E. G.

2796. *Paints for Compass Bowls and Discs.* **H. L. Smith.** (Journ. Sci. Instruments, 4. pp. 314–317, July, 1927.)—Considerable trouble has been experienced with paints for compass bowls and discs. The paint has become discoloured either generally or in spots; the alcohol used in filling the compass bowl has become discoloured; the paint has a tendency to flake or peel off. Three classes of paint are examined: (*a*) paints made with an oil medium; (*b*) paints made with an aqueous medium, *e.g.*, a solution of gum arabic; (*c*) paints made with solutions of nitrocellulose. A note is appended on the action of white lead on casein in the presence of lime. A. E. G.

2797. *The Conception of Forced Vibration.* **H. Schmidt.** (Zeits. f. Physik, 44. 1–2. pp. 113–117, 1927.)—The author considers that the conception of a forced vibration should be confined to the motion of a system from which the natural vibration of the system has been separated.
J. S. G. T.

2798. *Unrolling of Belts.* **R. Swyngedauw.** (Comptes Rendus, 185. pp. 252–254, July 25, 1927.)—When a belt leaves a pulley the straightening of the inside face only commences at the instant and at the point where this face leaves the pulley, while the straightening of the outside face may commence a short time earlier, as the stroboscopic method previously described [see Abstracts 1995 (1926) and 2444 (1927)] has shown. The two cases where belt slip does and does not take place are discussed. For the first case it is shown that a diminution of velocity is created by the straightening and that the loss of velocity is greater at the driving than at the driven pulley. Experiments have verified this. A. W.

2799. *Theoretical Gas Definition of Fluid Pressure.* **K. Shiba.** (Imp. Acad. Tokyo, Proc. 3. pp. 265–268, May, 1927.)—In hydrodynamics, pressure is defined in terms of an ideal surface in the fluid, while in the equation of state pressure means force per unit area on a solid or liquid boundary of a different material. Again, pressure in the kinetic theory of gases is defined as rate of transfer of momentum across a surface. It is shown that with cohesion or body forces present, these quantities are not all equal. W. G. B.

2800. *Diffusion of Small Particles in a Liquid.* **W. Weaver.** (Zeits. f. Physik, 43. 3–4. pp. 296–298, 1927.)—When small particles swim in a liquid they execute a Brownian movement and acquire a uniform condition whose velocity is determined by the Stokes law. Whatever the initial density of the particles in the liquid, the final state is always stationary and the density is then an exponential function of the depth. The important problem is now discussed of ascertaining the period before this stationary state has been attained, a problem which has recently been treated by Fürth [see Abstract 431 (1926)], whose conclusions, however, are very different from those of the author. The latter had established earlier that the stationary state is reached in all cases in the same time, *viz.*, that in which a particle would fall through the double depth of liquid when moving with the Stokes velocity. This result is now confirmed and the flow in Fürth's method of treatment made clear.
H. H. Ho.

2801. *Experimental Study of the Laminar Motion of a Viscous Liquid.* **B. Weinberg.** (Indian Journ. of Physics, 1. pp. 329–356, June, 1927.)—Previous work [see Abstract 2238 (1926)] has dealt with the transformation of solids and is now extended to liquids. § 1 of the paper accordingly discusses the notions " solid " and " liquid " ; § 2 then stresses the importance of the problem of studying the laminar motion of a viscous liquid ; § 3 deals with the choice and preparation of suitable liquids, after which § 4 enters on the study of the kinematic conditions of laminar motion which is extended to the kinetic conditions in § 5 ; in § 6 some results of the study of laminar motion of a viscous liquid in the case of immovable walls or of an immovable wall and a free surface are given ; § 7 discusses the flow between immovable and movable walls ; and § 8 contains an experimental study of the resistance of solids (pitch) to the laminar motion of a viscous liquid. The paper is replete with data and illustrations.

H. H. Ho.

2802. *Fluid Motions Round Infinitely Close Solids.* **D. Riabouchinsky.** (Comptes Rendus, 185. pp. 180–182, July 18, 1927.)—An alternative deduction of a previous result. [See Abstract 705 (1922).] W. G. B.

2803. *Incorrectness of the Navier-Stokes Hydrodynamics.* **M. Broszko.** (Zeits. f. Physik, 43. 7. pp. 480–498, 1927.)—By applying the ordinary equations of hydrodynamics to a *physically* small element, and using Reynolds' analysis, it is shown that the Navier-Stokes equations for viscous liquids are incorrect, and that the thermal agitation can only be considered as irregular in a fluid at rest. W. G. B.

2804. *Flow of Air and of an Inviscid Fluid Around an Elliptic Cylinder and an Aerofoil of Infinite Span, especially in the Region of the Forward Stagnation Point.* **A. Fage.** (Roy. Soc., Phil. Trans. 226. pp. 1–19, July 12, 1927.)—The relationship between the inviscid and the wind-tunnel flows at the nose of an elliptic cylinder and of an aerofoil of infinite span are examined in detail. The investigation consists of three parts. In the first the experiments made with an elliptic cylinder of large eccentricity (0·96757) are analysed, this particular model being selected because the position of the stagnation point for an inviscid flow can be mathematically determined and the shape approximates to that of an aerofoil. A model aerofoil is also used. A flow pattern for an elliptic cylinder is mapped out in an " electrical tank " and compared with that deduced by theory (Part II). In Part III the analysis for the aerofoil is given. [See also Abstracts 439 and 675 (1926).] J. K.

2805. *The Stability Problem of the Poiseuille and Couette Current.* **T. Sexl.** (Ann. d. Physik, 83. 6. pp. 835–848, July 20, 1927.)—Previous stability investigations according to the method of small oscillations have considered propositions of Orr and Sommerfeld on two-dimensional currents between parallel walls, but even in these simplified cases the current can only be completely derived on a linear velocity distribution and leads to a negative result for the stability of this laminar motion. On the same basis the same result holds for all laminar currents between parallel walls (Noether) and also for parabolic profiles (Heisenberg). In the present investigation the Poiseuille currents in tubes and the Couette currents between rotating cylinders have been examined. For frictionless liquids and three dimensional disturbances very complex differential equations were obtained, and only approximate results have been derived, but the Poiseuille problem proved to be less difficult than the Couette. The paper is entirely mathematical. H. H. Ho.

2806. *Method of Images in Some Problems of Surface Waves.* **T. H. Havelock.** (Roy. Soc., Proc. 115. pp. 268–280, July 1, 1927.)—When a circular cylinder is submerged in a uniform stream the surface elevation may be calculated by a method consisting of replacing the cylinder by the equivalent doublet at its centre and then finding the fluid motion due to this doublet. In a previous paper [see Abstract 1338 (1917)] it was remarked that if the solution so obtained were interpreted in terms of an image system of sources, further approximations may be obtained by the method of successive images taken alternately in the surface of the submerged body on the free surface of the stream. This is effected in the paper for two dimensional fluid motion and applied to a circular cylinder. Before proceeding to the cylinder the author considers two cases in detail: (*a*) a horizontal doublet and (*b*) a vertical doublet. Numerical values are given. The second approximation for the circular cylinder is investigated. The paper is mathematical throughout. W. V. M.

2807. *Isotopes and the Periodic Law.* **G. Piccardi.** (Accad. Lincei, Atti, 5. pp. 439–443, March 20, 1927.)—The difference in mass between the lightest and the heaviest isotope of any element is termed the field of variation of the isotopes. The existence of a regular relationship between this quantity and the atomic number is sought. A. Wh.

2808. *Molecular Weight Determinations by Centrifuging.* **T. Svedberg.** (Zeits. phys. Chem. 127. pp. 51–70, June, 1927.)—In continuation of measurements of sedimentation equilibria by a high-speed centrifuge previously described [see Abstract 1998 (1926)], determinations are made of the molecular weight of carbon monoxide—hæmoglobin, met-hæmoglobin, and egg albumin by sedimentation velocities. A measurement is made of the displacement of the boundary between solution and solvent, and use is made of the relation :—

$$M = \frac{RT \ln \frac{x_2}{x_1}}{D(1 - \rho V)\omega^2(t_2 - t_1)},$$

where M is the molecular weight, x_1 and x_2 are the distances of the boundary from the rotation axis of the centrifuge at times t_1 and t_2, D is the diffusion constant, ρ the density of the solvent, ω the angular velocity, and V the partial specific volume. Expressions relating to mixtures are also derived. A new type of centrifuge which is employed is described. This is propelled by an oil turbine, and give speeds up to 40,000 r.p.m., thus providing a centrifugal force amounting to 90,000 times that of gravity. Boundary movements of the solution are recorded photographically, and the rotation velocity of the centrifuge is gauged by observation through a regulated stroboscope. J. N. P.

2809. *Atomic Weight of Scandium.* **N. H. Smith.** (Am. Chem. Soc., J. 49. pp. 1642–1650, July, 1927.)—Anhydrous scandium chloride is prepared by passing a stream of nitrogen and carbon tetrachloride vapour over highly-purified scandium oxide heated in a quartz tube to 700°–850° C. A fractional sublimation of the scandium chloride is then carried out in the same apparatus in a current of dry nitrogen, and the product transferred to a weighing bottle without exposing to the outside air. After dissolving a weighed amount of the scandium chloride in pure water, silver nitrate solution prepared from highly purified materials is added from a calibrated burette until exact equivalence is present as judged by a nephelometer. A standardised potassium chloride solution is used where necessary for back titration. The ratio of pure scandium chloride to pure silver is determined and the average of nine analyses gives 45·160 as the atomic weight of scandium. J. N. P.

2810. *Significance of Molecular Spectra. Part III. Notes on the Oscillation and Rotation Spectra of Molecules with More than Two Nuclei.* **F. Hund.** (Zeits. f. Physik, 43. 11–12. pp. 805–826, 1927.)—Previous work has dealt with the basis of the quantitative term scheme of a molecule with two (like or unlike) nuclei [see Abstract 2222 (1927)] and the present paper extends this to the cases of polyatomic molecules. In the case where a tetra- or polyatomic molecule possesses two mirror image-like arrangements of lowest potential energy, these are present equally in every stationary state. Transition between these arrangements corresponds to a frequency, a fact not in contradiction with the existence of optical isomers. The distribution in the term system for the molecule of equal nuclei is worked out for the oscillation case alone by consideration of normal co-ordinates, whereas for the case of rotation it follows from the properties of the special (eigen) functions of the top. H. H. Ho.

2811. *The Two Magnetic Moments of the Atom.* **R. Ferrier.** (Comptes Rendus, 184. pp. 1641–1643, June 27, 1927.)—The moments referred to are those of Bohr and Weiss, as determined respectively by the study of spectra and from the magnetic field set up by the particle. According to the author the two moments are independent, and this view is supported by conclusions drawn from the application of the general equations of the electric field. G. E. A.

2812. *The Total Energy of Binding of a Heavy Atom.* **E. A. Milne.** (Cambridge Phil. Soc., Proc. 23. pp. 794–799, July, 1927.)—L. H. Thomas has recently calculated approximately the field in the interior of a heavy atom, using a six-dimensional phase space. An equation is found which is very similar in form to Emden's equation for gaseous spheres, which is the basis of Eddington's theory of the internal constitution of the stars. The present paper applies Emden's method to determine the total electrostatic potential energy E of an atom built on the Thomson model, thus obtaining the total binding energy of the electrons; according to the theory this is proportional to $N^{\frac{7}{3}}$. It should also be equal to the sum of the successive ionisation potentials. This has been calculated by Hartree for certain atoms, and the two sets of values are shown to be in agreement. H. N. A.

2813. *The Connection between the Formation of Complex Compounds and the Structure of the Central Atom.* **H. Lessheim, J. Meyer** and **R. Samuel.** (Zeits. f. Physik, 43. 3–4. pp. 199–221, 1927.)—The paper deals mainly with what are spoken of as "genuine" complexes, such as those formed by trivalent cobalt $[Co(NH_3)_6]Cl_3$, and its numerous derivatives.

The six molecules of NH_3 are regarded as joined to the Co, not by the principal valence electrons, but by the six electrons of the outermost closed sub-group 3_{33}, so that the bonds have definite directions in space, and isomers are possible in the derivatives, which is not the case in other complexes, such as those formed in crystals containing water of crystallisation, where the union may be due to electrostatic forces, the atomic groups being simply packed round the central atom so as to fill up the available space, and not attached by definite bonds to particular portions of it. Special attention is devoted to the complexes formed by the elements from V^{5+} to Zn^{2+} and Zn. The coordination number, or number of groups joined to the central atom, is, 0, 4 or 6, and certain regularities in the occurrence of these numbers are pointed out. Complexes formed by other elements are considered, and similar regularities found. The magnetic properties of complexes are also dealt with. H. N. A.

2814. *New Scheme of Atomic Structure.* **M. N. Saha.** (Phys. Zeits. 28. pp. 469–473, July 1, 1927.)—Rejecting, as in a previous paper [see Abstract 1982 (1927)], the subdivision of levels like M_3 into M_{32} and M_{33}, and referring to Hund and Pauli, the author gives diagrams of the structures of the atoms. If X stands generally for any level K, L, M, and the electrons of X have the characteristics of a doublet S term $(2s\frac{1}{2})$, those of Z_2 the characteristics of doublet *p* terms $(2p\,.\,\frac{1}{2}\,.\,\frac{3}{2})$, etc., and if the fully occupied level (shell) has two electrons for X_1, 6 electrons for X_2, 10 for X_3, 14 for X_4, then all the elements can be arranged in five regular groups (Li to Ne, Na to A, Cu to Kr, Ag to Xe, Au to Nt) and in groups of the intermediate transitional elements. H and He stand apart. In order to elucidate the optical spectra, the M, N, etc., are written in horizontal rows so staggered that the $L_1\,M_1\,N_1\,O_1$ and the $L_2\,M_2\,N_2\,O_2$, etc., are in parallel diagonals. When the ionisation volts are plotted as ordinates against the atomic numbers as abscissæ, an irregularly peaked curve is obtained. When an outer shell is fully occupied, as in the Ne atom, it is very difficult to detach or to excite an electron, and still more difficult to add one. In the O and F atoms, where the shell is nearly occupied, the ionisation potential is high; the atoms rather take up one or two more electrons than give up one, and the valency is negative, one or two, never positive. H. B.

2815. *Atomic Structure of AuSn.* **G. D. Preston** and **E. A. Owen.** (Phil. Mag. 4. pp. 133–147, July, 1927.)—The material was examined by the powder method with a Müller camera, the radiation being emitted by an X-ray tube of the authors (a porcelain tube with rubber washers and detachable electrodes) [see Abstract 391 (1927)], by the rotating crystal method, and by the Laue method, the crystal used being a chip, 1 mm. in cross-section, 3 mm. long. Exposures of three hours and more were applied. The twenty-six lines observed can all be accounted for by assuming a hexagonal lattice structure of side 4·309 Å. and axial ratio 1·275, the unit hexagonal prism containing 2 (1·96) molecules. In pure tin the smallest distance between atoms is 2·80 Å., in pure gold 2·88 Å.; the mean of these two distances, 2·84 Å., is equal to the deduced distance between two atoms in the alloy, 2·842 Å. The intensity estimates of the reflections on the powder photographs agree with a structure in which the gold atoms are situated at the points (000) and $(00\frac{1}{2})$, and the tin atoms at the points $(\frac{1}{3}\,\frac{2}{3}\,\frac{1}{4})$ and $(\frac{2}{3}\,\frac{1}{3}\,\frac{3}{4})$. H. B.

2816. *Crystal Structure of Ammonium Fluoride.* **W. Zachariasen.** (Zeits. phys. Chem. 127. 3–4. pp. 218–224, July, 1927.)—The crystals are, according to Goldschmidt, hexagonal, doubly-refracting and of density 1·015. The X-ray examination was made with the powdered salt by the Debye method, and with a crystal (fused into a flat glass tube) by the Laue method; the vapour pressure of the fluoride being high, the former method did not give very good radiograms at ordinary temperature. The crystal is of the ZnO type. The unit cell has the dimension $a = 4\cdot 39$ Å. and $c = 7\cdot 02$ Å., $c/a = 1\cdot 6$, and would thus contain 2 mols. The tendency of the NH_4F to dissociate into $NH_3 + FH$ even at ordinary temperature is indicated in the radiogram which suggests that the N atom is in the centre of a tetrahedron of the 4H, and that the F atom lies in one NH-axis, so that this H atom would occupy a special position. The radiograms of ammonium chloride, bromide and iodide do not show this polarisation of one of the H. H. B.

2817. *Zinc Blende, Wurtzite Lattices and Ionic Lattices.* **G. v. Hevesy.** (Zeits. phys. Chem. 127. 5–6. pp. 401–414, July, 1927.)—Different methods have been employed to find out whether the components of a lattice are ions or uncharged particles. The author shows that the electrolytic conductivity of the crystals, and of their melts, gives information on this point, and that in the majority of cases both kinds of particle *seem* to exist in a crystal. This is explained, in terms of the new quantum theory, by supposing that in some crystals the field of the valence electron of the metallic component is almost entirely confined to the neighbourhood of the other component, in which case the components are all positive and negative ions. In other cases this field is shared, more or less, between the two components, and then the crystal will behave as though it were composed partly of ions and partly of uncharged atoms. In the case of BeO, which crystallises in the zinc blende lattice, the conductivity data are shown to indicate that most of the component particles are uncharged, which agrees with the conclusions of Grimm and Sommerfeld and of Goldschmidt. αAgI is shown to have an ionic lattice, and βAgI an atomic lattice. Metallic conductivity is connected with uncharged lattice components. H. N. A.

2818. *Crystal Growth in Super-Saturated Liquids.* **H. A. Miers.** (Inst. of Metals, J. 37. 1. pp. 331–350, 1927. Engineer, 143. p. 527, May 13, 1927. Abstract.)—A valuable survey dealing chiefly with the facts concerning the first appearance of crystals from solution. The author's work of some twenty years ago on under-cooling is summarised, and recent applications of it are discussed. More than seventy important references are given. W. H. Ge.

2819. *Crystal Structure of α-Manganese.* **A. J. Bradley** and **J. Thewlis.** (Roy. Soc., Proc. 115. pp. 456–471, July 1, 1927.)—The nomenclature of Westgren and Phragmén is adopted, and their measurements are employed in working out the structure [see Abstract 32 (1926)]. After a long process of elimination the authors have arrived at a solution for the complete atomic arrangement, which appears to be the only one which will explain the data. Westgren and Phragmén found that the structure is cubic, with lattice dimensions 8·894 Å.; there are 58 atoms in the unit cell, and not 56 as given by Westgren and Phragmén; the space group is T_d^3, the whole arrangement is one single body centred cubic lattice, but each lattice point is represented by a cluster of 29 atoms with tetrahedral symmetry, which, however, are not to be regarded as chemical molecules or groups. The structure consists of atoms of four different kinds, 2 X atoms, 8 A atoms, 24 D_1 atoms, and 24 D_2 atoms in the unit cell. These differ from one another in size, and it is suggested that this is due to the electrons being unequally shared between them. The exact position of the atoms is defined by five parameters, which have been evaluated. H. N. A.

2820. *Construction of Crystals.* **V. M. Goldschmidt.** (Zeits. techn. Physik, 8. 7. pp. 251–264, 1927.)—The writer attempts to lay down general rules for crystal building from a consideration of our present knowledge of crystal structure. Ionic crystals are built on purely geometrical principles from units (atoms or groups thereof) of definite size. Metallic structures are largely controlled by the polarisability of the atoms, and are regarded as a kind of multi-nuclear pseudo atom with a binding web of electrons. Other crystal structures are intermediate between these two extremes. The author shows from examples how the physical and chemical properties, and even the characteristic properties of metals are consequences of their structure. Many references are given, and the paper serves as a valuable summary of much of our present knowledge of crystal structure and its significance. J. E.

2821. *Study of Muscovite Mica by X-Rays.* **C. Mauguin.** (Comptes Rendus, 185. pp. 288–291, July 25, 1927.)—Muscovite or white mica, $Al_3Si_3KH_2O_{12}$, has 21 atoms. The author aims at determining the Federov-Schönflies space group. CuKα radiation was used with a cylindrical camera and a graphical method already described by the author for interpreting the diagrams. This method furnishes a " net diagram." In this case the unit cell is a monoclinic prism on a rhombic base. The absence of *p o r* reflections when *r* is odd indicates that the crystal has only a glide plane of symmetry. The point group is repeated by a reflection in 010 plus a translation of ½*c*. There are two " molecules " per unit cell. If one compares the X-ray results with other information, one can say that Muscovite mica is a pile of sheets 9·95 Å. thick. Each layer consists of molecules arranged on an equilateral triangle plan ($a = 5{\cdot}17$ Å.). J. E.

2822. *Interpretation of Orthorhombic Powder Photographs.* **J. O. Wilhelm.** (Roy. Soc. Canada, Trans. 21. Sect. 3. pp. 41–43, March, 1927.)—Extends to the orthorhombic system the graphical method of Hull and Davey for the determination of crystal structures by the analysis of powder X-ray photographs. The eight charts given, though drawn for the simple orthorhombic system, are applicable to the body-centred, the face-centred and the diamond-like divisions of the system. The series of charts shows the dependence of the spacings upon one of the axial ratios *A* whilst the other axial ratio *C* is kept constant. The values of *C* range from 0·7 to 1·5. W. H. Ge.

2823. *Debye-Scherrer X-Ray Photographs.* **G. Kurdjumow.** (Zeits. f. Physik, 43. 11–12. pp. 921–933, 1927.)—A consideration of the influence of the size and divergence of the X-ray beam and the size and alignment

of the object upon the width of the lines in the photograph. By a suitable slit arrangement the breadth of a line can be reduced to 0·15 mm.
W. H. Gr.

2824. *Moments of Rotation and Undulatory Mechanics.* **L. Brillouin.** (J. de Physique et le Radium, 8. pp. 74–84, Feb., 1927.)—On the basis of the undulatory mechanics expressions are derived for the moments of rotation of a charged body in a central field. Formulæ similar to those derived from matrix mechanics are obtained, but integral quantum numbers are found. In a magnetic field a normal Zeeman effect and paramagnetism are defined by formulæ similar to those given by the older quantum mechanics, but rotation of electrons is essential to account for the abnormal Zeeman effect.
A. Wh.

2825. *A New Foundation for Quantum Mechanics. Part II.* **P. Jordan.** (Zeits. f. Physik, 44. 1–2. pp. 1–25, 1927.)—In this paper a simplified and generalised version of the theory developed in Part I [see Abstract 1290 (1927)] is given. This was rendered necessary since only the theory of continuous quantum-mechanical quantities had been completely developed in Part I, whereas the discontinuous magnitudes had not been submitted to exact examination. It now appears that the canonical exchange rule, $pq - qp = h \,.\, (2\pi i)^{-1}$ only applies to continuous quantities p, q, and it is incorrect for a quantelated effective variable J to place $J\omega - \omega J = h \,.\, (2\pi i)^{-1}$, whilst the same equation is also invalid in the theory of magneto-electrons. On the other hand, the canonical conjugated quantities defined in Part I are generally applicable. The results of Dirac [see Abstract 1292 (1927)] are quoted.
H. H. Ho.

2826. *Symmetry Characteristics of Terms for Systems of Similar Particles in Quantum Mechanics.* **F. Hund.** (Zeits. f. Physik, 43. 11–12. pp. 788–804, 1927.)—An amplification of the work of Heisenberg [see Abstract 297 (1927)]. The arrangement of terms of a system of particles is treated by a general method for certain arrangements of the particles, the classification being one of characteristic functions into various symmetry characteristics. The results of Wigner are reconsidered, and a simple answer is found to the question of which terms become anti-symmetrical on the introduction of new properties of the particle (*e.g.*, the magnetic moment of the electron). The multiplet system of the spectrum is deduced for any number of electrons from the quantum mechanical properties of the system.
W. V. M.

2827. *Classical and Undulatory Mechanics in a Five-Dimensional World.* **L. de Broglie.** (J. de Physique et le Radium, 8. pp. 65–73, Feb., 1927.)—A discussion of the five-dimensional world suggested by Kaluza and Kramers.
A. Wh.

2828. *The Problem of Three Bodies.* **G. Tiercy.** (Arch. des Sciences, 9. pp. 16–31, Jan.–Feb., 1927.)—Entirely mathematical.
A. Wh.

2829. *Periodic Orbits of the Second Class.* **D. Buchanan.** (Roy. Soc., Proc. 114. pp. 490–516, April 1, 1927.)—Second genus orbits of an infinitesimal body moving in the vicinity of the Lagrangian straight line equilibrium points in the restricted problem of three bodies are considered. The paper is wholly mathematical.
A. Wh.

2830. *The Physical Reality of Light Quanta.* **M. Planck.** (Frank. Inst., J. **204.** pp. 13–18, July, 1927.)—The author first discusses the approximate validity of the laws of mechanics taking for example the motion of an electron and pointing out that corpuscular mechanics resolves itself into undulatory mechanics, a solid foundation for which has been established by de Broglie and Schrödinger in agreement with Heisenberg's postulates. He then considers electromagnetic radiation, which *in vacuo* at high frequencies appears to move in definite light quanta, and discusses at some length the still unsolved question as to whether a physical reality must be ascribed to these quanta or whether some account of them can be given which preserves the validity of Maxwell's classical electrodynamics. This question, the author opines, will only be solved when corpuscular and wave physics are proved to be but sections of a unified system.

H. H. Ho.

2831. *Relativistic Quantum Theory.* **J. Struik** and **N. Wiener.** (Comptes Rendus, **185.** pp. 184–185, July 18, 1927.)—The relativistic quantum theory developed in a previous paper [see Abstract 2472 (1927)] is extended to include Schrödinger's wave equation and the discontinuous distribution of energy required by Bohr's theory. J. S. G. T.

2832. *The Gravitational Equations of the General Theory of Relativity.* **G. v. Gleich.** (Zeits. f. Physik, **44.** 1–2. pp. 118–132, 1927.)—The author discriminates between the notions of time employed in the special and general theories of relativity respectively, and shows that Einstein's equations of the gravitational field do not unequivocally define a metric of space, nor do they even specify the elliptic motion of the planets, as not one of the arbitrary constants concerned is definitely evaluated. A relativistic theory of a so-called "world horizon" would appear to be untenable.

J. S. G. T.

2833. *The Coupling of Electromagnetism with Gravitation.* **E. Reichenbächer.** (Zeits. f. Physik, **44.** 6–7. pp. 517–534, 1927.)—It is shown that the introduction of the Riemannian curvature corresponding to the fundamental tensor, $\gamma_{\mu\nu} = g_{\mu\nu} - \epsilon^2\phi_\mu\phi_\nu$, into the world function leads either to no electromagnetic field equations or to the correct equations of the gravitational field. J. S. G. T.

METEOROLOGY AND GEO-PHYSICS.

2834. *Atmospheric Disperse Systems.* **A. Stäger.** (Kolloid Zeits. **42.** pp. 223–229, July, 1927.)—A review is given of existing knowledge on the influence exerted by highly dispersed solid matter on atmospheric phenomena. The optical effects described include twilight phenomena, alpine glow, and zodiacal light. Results are given of determinations of atmospheric turbility by measurement of the solar constant. The position of neutral points in polarised light as reflected from the sky is displaced by solid suspensoids and measurements of this effect have enabled information to be obtained of the origin of dusts. The influence of solid nuclei in determining different types of cloud formation is discussed. Suspended matter including water and ice particles may lead to a very large increase of the normal potential gradient and conductivity of the atmosphere due to absorption of ions, the action of ultra-violet light, dispersion of

water drops and surface electrification. Luminescence phenomena may in this way be produced by sand storms through electrical action. The main distinction between atmospheric precipitation and the coagulation of a hydrosol lies in the electrical phenomena accompanying the former. The directions in which further investigations are desired are pointed out.
J. N. P.

2835. *Temperature in the Upper Levels of the Atmosphere.* **H. Petersen.** (Phys. Zeits. 28. pp. 510–513, July 15, 1927.)—Lindemann and Dobson from observations on meteors found a temperature at 60 km. approximately the same as that at the earth's surface, while Gutenberg from observations on waves caused by explosions found temperatures of 0° C. at 40 km., 20° C. at 50 km. and 40° C. at 60 km. Assuming that magnetic storms are due to a corpuscular radiation from the sun (β-rays) and that these rays are deviated by the earth's magnetic field, Birkeland calculated the order of magnitude of the current produced. The author assumes that this radiation is wholly or partially absorbed at great heights in the atmosphere, and he seeks to show that so much heat is developed that there must be an important rise of temperature in the absorbing air masses, and that the conditions under which this temperature-rise takes place are such that an increase of temperature with height is to be expected. An approximate value is obtained for this, but a quantitative calculation would involve further arbitrary assumptions such as the kind of radiation, composition of the atmosphere, etc., so that the detailed results obtained would be scarcely justified.
R. S. R.

ASTRO-PHYSICS.

2836. *Star Streams and the Solar Apex.* **V. Nechvile.** (Comptes Rendus, 184. pp. 672–674, March 14, 1927.)—From proper movements of 3786 stars of magnitudes 5 to 16, the number in each Kapteyn current and its velocity have been determined. The solar apex is determined by two methods, due to Airy and Eddington. The results agree well, being

$$\alpha + 286^\circ{\cdot}9,\ +281^\circ{\cdot}3$$
$$\delta + 46^\circ{\cdot}3,\ +45^\circ{\cdot}6.$$

Errata (*ibid.* p. 788, March 21, 1927).
A. Wh.

2837. *Wolfer's Sunspot Numbers and Periodicities in Disturbed Series.* **G. U. Yule.** (Roy. Soc., Phil. Trans. 226. pp. 267–298, April 28, 1927.)—An inspection of curves drawn from Wolfer's sunspot numbers indicates that they represent certain periodicities modified by sudden changes of amplitude and phase rather than undisturbed periodicities obscured by fortuitous errors. The paper is mainly mathematical and demonstrates a method of computation based on this idea. Examples are given, and certain apparent systematic features in the disturbances noted. A. Wh.

2838. *Refraction by the Solar Atmosphere.* **K. Sotome.** (Imp. Acad. Tôkyô, Proc. 3. pp. 251–254, May, 1927.)—Earlier investigations of this subject assumed a mean value for the angular velocity of the sunspots. As this actually varies the author obtains an expression for the total shift due to the refraction effect in the form :

$$(A + B)\tan(\rho + \rho') - [A^2 \tan^3 (\rho + \rho)_1]/2,$$

where $A = (n - 1)/n$, $B = dR/(R - dR)$, R is the sun's radius, dR the depth of the spot, p the geocentric angular distance of the sunspot from the centre of the disc, p' the heliocentric angle between the earth and the spot, and n is the index of refraction of the photosphere. Between 1886 and 1923 there were 648 cases of recurrent sunspots available from Greenwich records, and these were employed to calculate $(A + B)$ and $A^2/2$. These indicate that the sun's spots are not depressed holes in the photosphere. Assuming that the so-called depth-parallax is of much less importance than the refraction effect, n is found to be 1·00189. The augmentation of the apparent semi-diameter of the sun due to refraction effect is approximately 0·00189R, or 1″·81 for a solar radius of 16′ corresponding to a height of 131·4 m. The necessary longitude and latitude corrections for the refraction of sunspots are then stated. R. S. R.

2839. *Equilibrium of the Calcium Chromosphere.* **P. A. Taylor.** (Roy. Astron. Soc., M.N. 87. pp. 605–616, June, 1927.)—The paper is intended to modify Milne's theory of the equilibrium of the calcium chromosphere [see Abstracts 703 and 2790 (1926)] by taking account of the curvature of the sun's surface and the variation of gravitational intensity with distance from the centre of the sun. The fundamental equations are established, making use of the above conditions, but otherwise using the same assumptions as Milne. The inverse square law of gravitation is used, but the gravitation of the chromosphere is neglected, this approximation being found to be justified in the cases considered. A parameter μ' is made use of, which plays a similar part to μ the coefficient of partial support in Milne's paper, but is not quite the same. For the case $\mu' = 0$ a value is obtained for $\tau(1 \cdot 80 \times 10^{-8}$ sec.), the same as found by Milne. For $\mu' \neq 0$ the general relation of μ' to μ is found. Curves illustrate the density of atoms per c.c. for $\mu' = 0$, 10^{-4}, and 10^{-3}, while for comparison curves obtained from Milne's formulæ are added for $\mu = 0$. It was found that in no case was $(n_2/n) > 6 \cdot 74 \times 10^{-3}$, n_2 being the number of atoms in the excited (1π) state. It was also found for $\mu' = 0$, 10^{-4} and 10^{-3}, that the limiting densities at great distances from the sun were respectively $(5 \cdot 56, 0 \cdot 0474$ and $5 \cdot 75 \times 10^{-36}) \times \Delta\lambda$ atoms per c.c.

R. S. R.

2840. *Light Intensity of the Calcium Chromosphere.* **P. A. Taylor.** (Roy. Astron. Soc., M.N. 87. pp. 616–625, June, 1927.)—The results obtained in a previous paper [see preceding Abstract] are applied to the calculation of the H and K radiation as observed in a telescope pointed near the limb of the sun in terms of the height above the limb of the point towards which the telescope is directed. The final integration can only be carried out numerically, and it is performed for $\mu' = 0$ and 10^{-4} (*i.e.*, $\mu = 2 \cdot 18 \times 10^{-5}$, and 10^{-4}). Curves are obtained connecting I_v and y/a for $\mu = 0$ and 10^{-4}, where I_v is the intensity of radiation of frequency v, y the perpendicular distance from the centre of the sun to the beam of light considered, and a the radius of the sun. The results are compared with some recent eclipse observations. It is indicated that the chromosphere is not "fully supported," and in the light of the rather scanty observational material available the coefficient of partial support is of the order of magnitude 10^{-4}. Thus, in the limit of great heights about 10^{-4} of the weight of the atom is balanced by the pressure gradient, the remainder of the weight being balanced by the radiation pressure. R. S. R.

2841. *Fine Spectral Structure in the Sun's Gravitational Field.* **H. L. Vanderlinden.** (Comptes Rendus, 185. pp. 186–188, July 18, 1927.)—The author deduces Sommerfeld's expression for fine spectral structure in a Minkowskian field, and expressions for the displacement of spectral lines and bands in a gravitational field. In particular it is shown that a Deslandres spectral series is displaced towards the red by the rotation of a molecule about a fixed axis. J. S. G. T.

2842. *Quantitative Researches on Absorption Lines in the Solar Spectrum.* **H. v. Klüber.** (Zeits. f. Physik, 44. 6-9. pp. 481–516, 1927.)—In two sections. The first is devoted to a summary of existing theories and formulæ, and is entirely mathematical; the second gives a lengthy and detailed account of photometric observations carried out with the telescope of the Einstein tower, which has been described in a recent publication. The paper contains numerous tables and curves, and gives copious references to the work of previous investigators from 1870 onwards. E. F.

2843. *Polarisation of Light Reflected from Rough Surfaces, with Special Reference to Light Reflected by the Moon.* **F. E. Wright.** (Nat. Acad. Sci., Proc. 13. pp. 535-540, July, 1927.)—An investigation from the geologist's point of view to determine, if possible, what substances are exposed at the moon's surface, the principle adopted being to note the changes occurring in the sun's rays on reflection from the moon's surface in comparison with the direct sun's rays, and then comparing these changes with the effects produced on reflection by terrestrial materials. Among the several changes which occur only the polarisation phenomena are considered. A new type of polarisation photometer has been devised, as in the other types available the object is not imaged on the photometric field, and is used as an eyepiece in the 12-in. refracting telescope at the U.S. Naval Observatory. For measurements with terrestrial materials this polarisation photometer eyepiece is temporarily converted into a telescope by the addition of a small objective mounted in an extension tube. Three curves are given showing the amounts of the polarisation produced on the reflection of a plane parallel beam of white light incident, at different angles on polished and ground plates of silica and flint glass; rough fracture surfaces of different specimens of basalt; and on pumice, quartz, porphyry, limestone and the powders of different transparent substances, such as quartz, sulphur, siliceous sinter and glass. The results so far obtained (for the work is still in progress) indicate that dark rocks low in silica, such as basalts, peridotites, serpentines, gabbros, etc., are not directly exposed on the moon's surface. Masses of iron, large ice masses, glassy obsidians, and powders of basic rocks are also not to be found. Pumiceous substances high in silica, powders of transparent substances and quartz porphyries, and possibly trachytes and granites, are indicated as the materials we see on the moon's surface, a result to be anticipated when the moon's density of 3·4, as against 5·5 for the earth, is taken into consideration. J. K.

2844. *Determination of Hour and Latitude.* **E. Paloque.** (Rev. d'Optique, 6. pp. 275–286, June–July, 1927.)—A new apparatus described, designed for observation of the simultaneous passage of two stars in the same azimuthal plane. The instrumental constants are eliminated by reversing the instrument; and the method eliminates the effect of refraction and its variations, so that the calculations are simple. A. D.

2845. *Increased Resolving Power in the Presence of Spherical Aberration.* **R. Kingslake.** (Roy. Astron. Soc., M.N. 87. pp. 634–638, June, 1927.) —It is known that double stars have sometimes been resolved with separations far below the theoretical limit of resolution of the telescope used. The investigation described in this paper shows that an objective with a certain amount of spherical aberration, equal to 1¼ times the Rayleigh limit, may give better resolution of close doubles than a perfectly corrected objective. With this aberration, which may easily occur with certain types of object-glass when changing temperature, the central dot of the Airy disc becomes very small, the first diffraction ring sharply defined, and the intermediate circular space absolutely dark. A double star is then specially well resolved in the dark space, although a clear image of an extended object, such as a planet or the moon, would not be obtained.

M. A. E.

2846. *Corrections to Mass of Venus.* **J. K. Fotheringham.** (Roy. Astron. Soc., M.N. 87. pp. 582–602, June, 1927.)—The author urges that the forms of equation used by Newcomb, Cowell, Ross, Hough and Jones take no account of any progressive change in the observed as compared with the tabular longitude, especially as the Greenwich observations, 1803–1882, are solved in four-year groups and such contain almost exact periods of some Venus terms. He discusses Brown's suggested changes in tabular coefficients; and points out that, in their investigations, Leverrier, Cowell and Jones have all made errors equivalent to a change of sign in certain terms. He urges that a comparison of the evidence indicates small mass for Venus for 1750–1830, large for 1831–1888, and medium from 1889; that these are real, and do not coincide with observed fluctuations in the motion of the moon. [See Abstract 2235 (1927).]

A. S. D. M.

2847. *Motions of Giant M Stars.* **G. Strömberg.** (Mt. Wilson Observat. Contrib. No. 332. Astrophys. J. 65. pp. 238–265, May, 1927.) —A determination of asymmetry in the motions of a homogeneous group of 278 M stars having large velocity dispersion. The velocities are projected on three axes, the y-axis being that of asymmetry and perpendicular to a plane that contains the x-axis, which is nearly parallel to the direction of the stream motion, and the z-axis, which is nearly perpendicular to the galactic plane. The distribution of velocities is represented by Charlier's method of moments, of which formulæ are given and numerical values tabulated and projected on the three axes. That on the x-axis is nearly a normal error curve; the "stream" motion is pronounced, but there is no trace of actual division into two streams, and the evidence is in favour of the ellipsoidal hypothesis. The y-axis projection differs markedly from a normal error curve, and the author represents the y-components by a function of the type $A\ exp[-a|y-c|-p(y-c)]$, and gives the values of a, p and c. The z-axis projection is also slightly asymmetrical, but this is probably not a general phenomenon as is the y-asymmetry. For the sun's motion from the M giants the author finds: $A_0 + 281°\cdot7$; $D_0 = +35°\cdot5$; $V_0 = 19\cdot8 \pm 1\cdot0$ km./sec., which agrees with that derived from radial velocities of 307 M stars, brighter than 6·5 apparent magnitude, in respect to the apices, but differs as to the velocity [see Abstract 2248 (1927)]. He discusses the nature of the asymmetry, and concludes that it affects the velocity distribution of all giant M stars and is the same for stars in general, and that the solar motion depends on velocity dispersion rather than on absolute magnitude. He considers Oorts' theory [see also Abstract 1739 (1924)] that certain stars have higher velocities than that of escape and are connected with the globular cluster system, but points out that the M stars differ from this in group motion, though they may be connected by a constant asymmetry vector. He also considers Lindblads' physical explanation of the asymmetry [see Abstract 2688 (1927)], but unfavourably. A. S. D. M.

2848. *Stars whose Spectra have Bright Iron Lines.* **P. W. Merrill.** (Mt. Wilson Observat. Contrib. No. 334. Astrophys. J. 65. pp. 286–294, June, 1927.)—Stellar spectra having bright iron lines may be classified in the following groups: (1) long-period variables; (2) peculiar stars of classes G, K and M; (3*a*) class Be normal; (3*b*) class Be peculiar; (4) novæ. Available information concerning these stars is summarised, and a few unpublished observations are recorded. Lists of stars in groups 2, 3*a*, and 3*b* are given, with references to published descriptions. New data are recorded for Z Canis Majoris (H.D. 53179), and B.D. + 14°3887. It seems possible that stars of group 3*b* (with outstanding bright lines and other peculiarities) have fainter absolute magnitudes than those of 3*a*. Lines of the ionised atom are of more frequent occurrence than those of the neutral atom. This fact is briefly discussed. AUTHOR.

2849. *Spectrographic Orbits of the Two Components of Boss 5683.* **R. F. Sanford.** (Mt. Wilson Observat. Contrib. No. 333. Astrophys. J. 65. pp. 295–299, June, 1927.)—Star B of the visual system Σ 2873 is a spectroscopic binary in which two spectra of about class G4 are at times distinguishable and measurable. The spectroscopic orbit of the primary and the semi-amplitude of velocity variation for the secondary have been found from thirty-eight spectrograms made with the 60-in. reflector. The orbit is circular, with a period of 1·1522019 days; the semi-amplitudes of velocity variation for primary and secondary are 105·5 and 112·4 km./sec., respectively, and the velocity of the system − 17·0 km./sec. A velocity diagram is shown. The elements give $(a_1 + a_2) \sin i = 3{,}470{,}000$ km.; $m_1 \sin^3 i = 0 \cdot 65 \odot$; and $m_2 \sin^3 i \times 0.61 \odot$. The velocity of the system here found is 5 km./sec. greater, algebraically, than that derived for star A, a difference hardly too large to attribute to the respective probable errors, although part of it may find a legitimate explanation in the orbital motion of the components of the visual system. Attention is called to the possibility of variability by eclipse. AUTHOR.

2850. *Influence of Atmospheric Conditions on the Effective Wave-Lengths of Stars.* **R. A. Robb.** (Astrophys. J. 65. pp. 315–320, June, 1927.)—By comparing the observed with the computed value of the "constant" of the objective grating, allowance can be made for the effect of the state of the atmosphere on effective wave-lengths. The scale-unit employed was that used by Parkhurst in his determination of the photometric magnitudes of the stars in the Kapteyn zone + 45°. AUTHOR.

LIGHT.

2851. *Ostwald's Theory of Colours.* **K. Schollmayer.** (Phys. Zeits. 28. pp. 504–510, July 15, 1927.)—Combats on experimental grounds certain objections to this theory (Ostwald's "Farbenlehre") raised by Schaefer [see Abstract 2313 (1926)]. A. D.

2852. *Laws of Colour.* **I. Runge.** (Zeits. techn. Physik, 8. 8. pp. 289–299, 1927.)—The author provides a comprehensive review of the scientific laws of colour as stated by Helmholtz and Schrödinger, particular regard being paid to their application. Among the subjects dealt with are (1) the variety of colour and its presentation according to the Maxwellian colour triangle; (2) the method used to establish the spectrum colours in this triangle and the possible different systems for the colours; (3) the calculation of colour coordinates from the spectrum distribution of energy; (4) the relation of brightness to the problem of indication of colour; (5) the calculation of brightness from the spectrum distribution of energy and from colour coordinates; and (6) a review of a complete colour theory. R. S. R.

2853. *Investigation of the Laws of Colour.* **A. Klughardt.** (Zeits. techn. Physik, 8. 8. pp. 299–307, 1927.)—The paper deals with the establishment of colour relations for spectral lines and spectral regions on the basis of the Young-Helmholtz colour theory, using the basic curves of perception given by König and Dieterici. These perception curves form the starting point of the investigation of the colour aspect of individual spectral lines with regard to saturation and shade, and the individual tones of numerous red and blue shades are established. In the broad spectral regions limits are obtained corresponding in their appearance to tones in the individual perception curves. The colour curves obtained differ from those of Ostwald by the existence of three main points (red, green and blue) instead of four. The distribution of the colour curves set up in this way eliminates some of the errors introduced in the Ostwald method. The basis for the determination of the new normal colour points was formed by the combination equations for the emission of light from various coloured surfaces. These equations, based on the red, green and blue perceptions, determined the spectral limits for individual colour tones. R. S. R.

2854. *Some Colouring Agents in Glasses and Glazes.* **H. Jackson.** (Roy. Inst., Proc., Advance Proof [12 pp.], received July, 1927. Nature, 120. pp. 264–266, Aug. 20, and pp. 301–304, Aug. 27, 1927.)—A description is given of the conditions under which a wide range of colours can be introduced into glasses and glazes by means of the oxides of copper and iron, which illustrate fairly completely the manner in which most of the materials used in this connection behave. Reference is made to the occurrence of cuprous oxide as the colouring agent in the brilliant scarlet glass of the ancient Egyptians. Attention is drawn to colour effects obtainable by means of substances in suspension as distinct from solution in glasses. In describing the colour transformations which occur in various coloured glasses under different mixings and treatments, analogies are found in the similar behaviour of mixtures of coloured aqueous solutions of metallic salts. Colours produced in glasses by the influence of ultra-violet light, X-rays and radium radiations are described, and it is noted that glasses so coloured can be decolorised by heating to an appropriate temperature. It is found that these decolorised glasses show a marked absorption in some part or other of the ultra-violet spectrum. The presence of a small quantity of a suitable impurity in a glass appears essential for the formation of colour by the action of radiations. A. B. C. L.

2855. *An Integral Relation between the Slopes of the Branches of Porter Graphs.* **H. A. Blair.** (Optical Soc. America, J. and Rev. Sci. Inst. 15. pp. 1–16, July, 1927.)—A relation was found to exist between the slopes of the branches of the Porter graphs for a number of colours throughout the spectrum such that the slopes of the branches of each graph can be expressed as integral multiples of a common factor. Critical frequency measurements on the tactile sensoria which show a similar relation are discussed in corroboration. The relation is interpreted as indicating that the physiological effect measured by the critical frequency for any particular colour is made up of equal elements which start off in groups from different intensity thresholds. The possibility that these elements denote the action of single end organs or associated groups of end organs is discussed in the light of the measurements made by Adrian and Zotterman on the frequency of the nerve impulses due to the stimulation of single end organs. The interpretation is conformable to the "all-or-none" law. AUTHOR.

2856. *New Colorimeters.* **W. Ewald.** (Zeits. Instrumentenk. 47. pp. 360–365, July, 1927.)—Illustrated description of four instruments: (1) The Stammer colorimeter for mineral oil investigations, large size, for layers up to a height of 375 mm. Dark tube, container and plunger of metal or glass. (2) The same, but entirely of metal, and chiefly for investigating sugar. Rack and pinion device for shifting plunger. Maximum height of layer 270 mm., with four standard glasses for sugar, or two standard uranium glasses for mineral oil are provided, instead of the usual optical comparison apparatus, with Lummer-Brodhuhn's optical cube, which gives greater sensitiveness. (3) Dubosq's colorimeter for sugar and general laboratory investigations. (4) Heele-Gallenkamp's colorimeter, chiefly for physiological researches. E. F.

2857. *The Minima of Regular Reflection.* **H. S. Uhler.** (Optical Soc. America, J. and Rev. Sci. Inst. 14. pp. 460–469, June, 1927.)—In the first part of the paper typical quotations are given to show how inadequately the theoretical side of the problem has been treated by earlier writers. The main body of the paper is devoted to the derivation of new, unexpectedly simple functions of the index of refraction which give directly the minimum value of the reflecting power and the associated values of the angles of incidence and refraction when the index is either less than $2 - 3^{1/2}$ or greater than $2 + 3^{1/2}$. This is followed by paragraphs which present, without detailed proofs, new formulæ for the index of refraction and the angle of incidence in terms of the minimum value of the reflecting power, and for the index and reflecting power with the angle of incidence as independent variable. The closing paragraphs make the account complete by dealing with the behaviour of the minimum of reflecting power corresponding to normal incidence, that is, to values of the index of refraction falling within the interval $2 - 3^{1/2}$ to $2 + 3^{1/2}$. AUTHOR.

2858. *Reflecting Powers of Some Non-Oxidising Steels.* **(Miss) J. Clavier.** (Comptes Rendus, 185. pp. 264–266, July 25, 1927.)—Two samples of four different kinds of steel were used. For the tests a photographic photometer method with a scale of tints was used. The reflecting power of each sample was measured over the range of wave-lengths, 320 to 560 m.u., and one sample of each kind was exposed to air for two months, while the other samples were protected from air and moisture. When all were tested again no loss of reflecting power was found. The mirrors could be silvered without being attacked during the process, and they are likely to prove of great use for the large sizes required in astronomy. R. S. R.

2859. *Low Indices of Refraction.* **J. H. de Boer.** (K. Akad. Amsterdam, Proc. 30. 3. pp. 350–354, 1927. In English.)—A solution of HBF_4 (from HF and boric acid) acted upon with CsCl gives a powdery precipitate of $CsBF_4$; but this precipitate is transparent to green light, while it scatters other rays. For the green, the precipitate has the same index of refraction as the surrounding solution. The green may be modified to blue by dilution or by gentle heating, or to orange by concentration. The dispersion curve of the $CsBF_4$ has a less steep course than that of the solution; and for the point of intersection there is transparency. The dispersion curve of the potassium salt lies wholly under that of water until the temperature is raised, that of the rubidium salt intersects that of water at ordinary temperatures. A. D.

2860. *The Henry Wild Universal Theodolite.* **Ollivier.** (Rev. d'Optique, 6. pp. 193–241, June, 1927.)—In this apparatus a microscope is placed parallel to the telescope and at the side of it, and without change of position the operator can read each of the circles by means of an optical arrangement placing the images side by side. The usual movement of the double-thread reticule is replaced by a relative rotation of the two images, which brings the graduations into coincidence. Further, the mean of the readings on the diametrically opposite ends of the circle is obtained. By the use of a diverging lens a decrease of the length of the telescope is obtained. The apparatus is of particularly elaborate construction, but in spite of the small size, its horizontal circle and its small weight it can be used for geodetic operations. Operators habitually using the apparatus can obtain angular measurements with an error not greater than 1·5″, while when employed as a tacheometer measurements of distance can be obtained with an accuracy of 1 in 5000. R. S. R.

2861. *An Apochromatic Telescope Objective with Relatively Large Aperture and Small Diameter.* **H. L. Tardy.** (Rev. d'Optique, 6. pp. 264–267, June–July, 1927.)—A description is given of an objective formed of five separate lenses cemented together, and consisting in turn of crown glass, quartz, fluorspar, flint and crown glass. This combination is achromatic in four colours, the residual spectrum does not depart by 0·3 mm. from the focus, while it can be realised up to a diameter of about 30 mm. and with an aperture equivalent to F/7. A curve illustrates the degree of achromatism of the combination. R. S. R.

2862. *The Hartmann Method for the Study of Objectives.* **G. Sladbei.** (Rev. d'Optique, 6. pp. 257–263, June–July, 1927.)—Starting from Lehmann's formula for thin lenses, three expressions are obtained by simple integration connecting the distances of the object and image from the lens, and the focal length. These expressions were investigated experimentally by using light from a quartz mercury vapour lamp after filtering it through two selected solutions, and photographs in two different planes perpendicular to the optical axis were obtained. These photographs were measured with a micrometer. It was found that surface imperfections of the lens due to mechanical treatment and variations of refractive index during manufacture, both of which effects are accidental, make it impossible to establish a numerical relation between the aberrations and the position of conjugate focus. The experimental study of the Lehmann formula shows that it is not general, and could not find an application in the case of optical systems whose characteristics should be sufficiently the same as those of thin lenses. R. S. R.

2863. *Application of the Algebraic Aberration Equations to Optical Design.* **I. C. Gardner.** (Bureau of Standards, Sci. Papers No. 550, pp. 73–203, 1927.)—The author considers first the first order equations of imagery for a single lens and extends these to cover longitudinal and lateral chromatic aberrations, spherical aberration, coma, astigmatism and distortion of a single lens. These equations are then extended to a system of thin lenses, and the aberration equations are also extended. The third order thin lens equations are then applied to optical design in (1) the direct determination of the aberrations of a Ramsden eyepiece, (2) the design of a lens system which has given aberration characteristics, and (3) the design of a Kellner eyepiece. The aberrations of plane parallel plates and the third order aberrations of prisms are next considered, and the third order theory of imagery applied to a telescopic system containing a parallel plate and a prism. In the appendices are given (1) the notation and sign conventions used with the equivalent symbols as applied by Taylor; (2) the Seidel equations as given by Schwarzschild, with the method of derivation of the thin lens equations; (3) a series of plates giving dimensional drawings of the principal prisms used in optical systems; and (4) values of the functions of n used in the third order equations for n between 1·4 and 1·75. R. S. R.

2864. *New Form of Thermostat and Observation Tubes for Polarimetric Work.* **T. S. Patterson.** (Chem. Soc., J. pp. 1717–1720, July, 1927.)—By the arrangement described, the polarimeter tube is immersed in a bath which may be maintained at any desired temperature. The end plate of the polarimeter tube is kept dry by means of a current of dry air, so that, even when a freezing mixture of carbon dioxide and alcohol is used for cooling the tube, a clear view through the polarimeter tube is obtained. T. H. P.

2865. *Elliptical Polarisation on Reflection at a Liquid Surface.* **C. Bouhet.** (Comptes Rendus, 185. pp. 53–55, July 4, and pp. 200–201, July 18, 1927.)—In the former paper the author shows that Chaumont's method is applicable for finding the ellipticity and the orientation of the axes of an elliptic vibration; and in the latter he gives an array of measured results from different liquids. The reflection is always positive. Jamin obtained some negative results, indubitably due to contaminated surfaces;

his method gave some positive results which were too large. There is no obvious relation between the ellipticities and the superficial tensions, the indices of refraction, or the molecular anisotropies deduced from the magnetic birefringences. A. D.

2866. *Polarisation of Light at Metallic Cylindrical Surfaces.* **H. Pfenninger.** (Ann. d. Physik, 83. 6. pp. 753–796, July 20, 1927.)—In the theoretical section of the paper the method employed by H. Spohn has been followed. Spohn, however, considered only the case for an angle $\phi = \pi$ with metallic cylinders. The solutions given here are for ϕ near to π, such that $\sin(\pi - \phi) = \pi - \phi$, and also for points outside the real diffraction region. The formula obtained holds for $(a/\lambda) > 2$, where a is the radius of the cylinder, and it holds for the region of the visible spectrum. It was found that the component E_s of the intensity perpendicular to the axis of the wire reaches its maxima and minima for smaller angles of bending than for the other component E_p, while their relative displacement depends also upon the radius of the wire. The minima of E_s are not so dark nor are the maxima so bright as those of E_p. Further, the phase was always in advance of that of E_s, while in the minima the phase progressed irregularly. Accurate results were possible only when perfectly clean smooth wires were used. According to theory the influence of the kind of material is extremely small. In spite of the extreme feebleness of the light the authors were able to confirm all the consequences of theory in their experiments. R. S. R.

2867. *Influence of an Electric Field on the Optical Properties of Quartz.* **N. T. Ze.** (Comptes Rendus, 185. pp. 195–197, July 18, 1927.)—A method is described for the quantitative determination of the variation of refractivity of a rectangular parallelopiped of quartz subjected to the influence of an electric field along the electric axis. The variations observed are analogous to the deformations described in a previous paper [see Abstract 2764 (1927)], but it is pointed out that the effects are purely electro-optical, being accountable neither in magnitude nor in sign by the deformations with which they are associated, and that such deformations, produced by mechanical pressure, are not accompanied by the same optical effects. A. B. C. L.

2868. *Lag of the Kerr Effect.* **J. W. Beams** and **E. O. Lawrence.** (Nat. Acad. Sci., Proc. 13. pp. 505–510, July, 1927.)—The apparatus previously described [see Abstract 1020 (1927) is here used to measure the lag compared to carbon bisulphide of bromoform, chloroform and ethyl ether. The lag is found to be the same for all wave-lengths. The molecules of these substances are polar, while carbon bisulphide is not. It is concluded that only polar molecules show a lag greater than 10^{-9} sec. This is confirmed by benzene, which is non-polar, and shows no relative lag. There is a definite increase in lag with temperature. F. S.

2869. *Magnetic Dispersion.* **C. G. Darwin** and **W. H. Watson.** (Roy. Soc., Proc. 114. pp. 474–490, April 1, 1927.)—The experimental data available in Landolt-Bornstein and other sources on magnetic rotatory dispersion are collected and applied to different dispersion formulæ. Becquerel's formula $U = \frac{e}{2mc^2} \cdot \lambda \cdot \frac{dn}{d\lambda}$ gives an anomaly, γ, for the calculated value of e/m. No anomaly is higher than unity, and the value is usually about 0·6. Tables of data are given. A. Wh.

2870. *Rotatory Dispersion in the Ultra-Violet of Four Aqueous Solutions of Tartaric Acid.* **R. Descamps.** (Comptes Rendus, 184. pp. 1543–1546, June 20, 1927.)—Polarimetric measurements with a new apparatus [see Cotton and Descamps, Abstract 984 (1926); and Descamps, Abstract 1705 (1927)] have been made on four solutions of tartaric acid up to a wave-length of $\lambda = 2536$ Å.U. At these short wave-lengths even a 1 % solution (which is dextrorotatory for visible light) shows an enormous lævorotation $[\alpha]_{2536} = -856°$. The author concludes that if, as Longchambon holds, the lævorotatory form of tartaric acid which is present in the crystals is converted into a dextrorotatory form by dilution, the persistence of the lævo-form must be very great. T. M. L.

2871. *Optical Rotatory Dispersion.* **T. M. Lowry** and **W. R. C. Coode-Adams.** (Roy. Soc., Phil. Trans. 226. pp. 391–466, July 6, 1927.)—Concludes nearly twenty years' work on the measurement of the optical rotatory power of quartz as a test of the newer methods of studying the rotatory dispersion of organic compounds and to provide accurate data for a rigid study of the form of the curves of rotatory dispersion. Drude's simplified equation (1898) $\alpha = \Sigma k_n/(\lambda^2 - \lambda_n^2)$ is completely verified for (1) cases of simple rotatory dispersion $\alpha = k/(\lambda^2 - \lambda_0^2)$, including octyl and cane sugar, (2) cases of anomalous rotatory dispersion $\alpha = k_1/(\lambda^2 - \lambda_1^2) - k_2/(\lambda^2 - \lambda_2^2)$, such as ethyl tartrate and camphor, (3) cases of complex but normal dispersion $\alpha = k_1/(\lambda^2 - \lambda_1^2) + k_2/(\lambda^2 - \lambda_2^2)$, such as α-chlorocamphor and α-bromocamphor. Drude had put forward an equation $\alpha = k_1/(\lambda^2 - \lambda_1^2) - k/\lambda^2$; the authors began by adding an infra-red term, but found by experience that the infra-red terms might be represented by a small constant, so that their final equation took a form $\alpha = k_1/(\lambda^2 - \lambda_1^2) - k_2/(\lambda^2 - \lambda_2^2) - k$. Drude calculated his solitary k_1 from measurements of refraction; the authors calculate the k's from the rotations themselves; this can be done with much greater accuracy. Thus for quartz at 20° C. before and after regrinding:

$$\alpha = 9{\cdot}5644/(\lambda^2 - 0{\cdot}012742 - 2{\cdot}3114/(\lambda^2 - 0{\cdot}000974) - 0{\cdot}1915,$$

and

$$\alpha = 9{\cdot}5639/(\lambda^2 - 0{\cdot}0127493) - 2{\cdot}3113/(\lambda^2 - 0{\cdot}000974) - 0{\cdot}1905,$$

corresponding to a difference of 0·03° per mm. at $\lambda = 2327$ Å. The two characteristic wave-lengths λ_1 and λ_2 are then at 1130 and 310 Å. respectively; this agrees with Gifford's very exact data. The characteristic wave-lengths thus obtained are generally about 100 Å. greater than those at which a maximum is recorded in the molecular absorption coefficient of an organic compound. There are no marked systematic differences between the observed and calculated rotations; and the probable error in the value of α for quartz (second numerical equation above) in no part of the spectrum appreciably exceeds $\pm$ 0·002°/mm., and under favourable conditions falls to less than one-half this amount. A. D.

2872. *Natural Rotatory Dispersion in the Ultra-Violet of Aqueous Solutions of Neutral Tartrates of Sodium, Potassium and Ammonium.*

R. Descamps. (Comptes Rendus, 185. pp. 116–119, July 11, 1927.)—The rotatory powers of aqueous solutions of neutral tartrates of ammonium and of sodium potassium have been observed by Nutting [see Abstract 1639 (1904)]. The author has made fresh measurements with a special spectrophotometer. He finds that the power increases with the wave-length up to a maximum, and then suddenly decreases, and then changes sign. The anomalies of the dispersion curves here found confirm the idea of Lowry and Austin that it requires two terms to represent the rotatory power of alkaline tartrates [see Abstract 1592 (1922)]. J. E.

2873. *Dispersion of Ultra-Violet Rays by Liquid Organic Compounds.* **H. Voellmy.** (Zeits. phys. Chem. 127. 5–6. pp. 305–357, July, 1927.)—The results of measurements of the refractivities of a number of organic compounds for wave-lengths between about 2100 and 6560 Å. indicate the necessity for a new view of the additivity law of the molecular refraction. In general this law is obeyed only with a certain approximation, since deviations always occur, especially when the dispersion is measured in the neighbourhood of those regions where the substances absorb. The deviations depend on a reciprocal influence of the different groups which is perfectly individual, and is not yet amenable to quantitative prediction.
T. H. P.

2874. *Fluctuations of the Dielectric Constant in Liquids and Theories of Molecular Scattering of Light.* **K. R. Ramanathan.** (Indian Journ. of Physics, 1. pp. 413–436, June, 1927.)—Fluctuations of the dielectric constant in liquids are discussed from the molecular standpoint, and a modified formula is obtained relating the deviations of dielectric constant, molecular concentration and molecular polarisation. Revised expressions for the intensity and polarisation of light scattered as a result of such fluctuations are given in terms of the molecular theory. The corresponding modification necessary in Gans' phenomenological theory of scattering [see Abstract 2405 (1923)] is indicated and shown to lead to the same results as the molecular theory. Experimental evidence at present available is in favour of the revised expressions for the intensity of the scattered light. The fluctuations of concentration in a binary liquid mixture and the consequent scattering are reconsidered from the same standpoint.
W. S. S.

2875. *Molecular Scattering of Light in Solid Bodies. Part I. Scattering of Light in Crystalline Quartz and its Dependence on Temperature.* **G. Landsberg.** (Zeits. f. Physik, 43. 9–10. pp. 773–778, 1927.)—The author refers to previous work by Strutt and by Raman on the scattering of light by solid bodies, and their suggestions that it was due to molecular scattering. In his own experiments a point source of light was used, and a narrow beam from it concentrated on the quartz crystal. The scattered light was received on a photographic plate. Particular care was taken to exclude extraneous light. To determine whether the effect was due to molecular scattering and not to admixture of foreign bodies the variation of intensity with temperature was measured. The intensity of the scattered light was found to increase with rise of temperature and to be approximately proportional to the absolute temperature. Glass gave an intensity one hundred times as great owing to its want of homogeneity. In the quartz crystal investigated approximately 25 % of the scattered light was due to want of homogeneity, and the remaining 75 % due to molecular scattering. Further tests are in progress. R. S. R.

2876. *The Influence of Preliminary Illumination on a Photographic Plate.* **J. Hrdlička.** (Comptes Rendus, 185. pp. 120–122, July 11, 1927.)—Formulæ are worked out on the assumption that the photochemical effect of two successive exposures t_0 and t is the same as that of a single exposure, $T = t_0 + t$; experiments have been made with monochromatic light of different intensities, and good agreement has been found between the theoretical and experimental results. H. N. A.

2877. *Law of Blackening of Photographic Plates at Low Densities.* **E. A. Baker.** (Roy. Soc. Edinburgh, Proc. 47. 1. pp. 34–51, 1926–1927.)—If I be the illumination on a plate, t the exposure time, λ the wave-length, and D the resultant density, then :

$$\log I/I_0 = a\Delta + b\log_{10} t + \tfrac{1}{2}c\Delta^2 + d\Delta\log_{10} t + \tfrac{1}{2}e(\log_{10} t)^2 + \cdots$$

where $\Delta = \log_{10}(10^D - 1)$ and a, b, c, d, e, etc., are functions of λ.

Then p and q are defined by

$$p \equiv -\frac{\partial(\log I)}{\partial(\log t)} = -b - d\Delta - e\log_{10} t \ldots;$$

$$q \equiv \frac{\partial(\log_{10} I)}{\partial\Delta} = a + c\Delta + d\log_{10} t + \cdots$$

The densities measured are specular and panchromatic plates developed according to the maker's formula are used. As development increases I_0 decreases, q varies slightly in an inverse sense to the density and p is diminished whatever the density. Thus c and b are affected by the development, but not a and d. Detailed data and discussions are given for many makes of plate. The theory of deviation from the reciprocity law is also discussed. It is shown that empirically it appears that for short exposures the effect of light depends on It, for long exposures on I^2t. If quanta are supposed to behave as molecules obeying mass action principles, it becomes necessary to suppose that the action consists in the absorption of two quanta, the effect of the absorption of one alone being transitory. The quanta must be taken up by different components, since there is no ultra-violet discontinuity corresponding to doubled energy values. A theory is developed which agrees well with experiment and indicates that a possible explanation of the observed facts depends on the presence of two distinct absorbers in the emulsion, and these may be identified with the bromide and iodide constituents. A. Wh.

2878. *Time Effect in Photographic Bleaching.* **Lüppo-Cramer.** (Zeits. Wiss. Phot. 24. pp. 380–384, July, 1927.)—Some peculiar effects under equal It, but with varying time t, described and discussed. Variations with different desensibilators. A. D.

2879. *Contrast of Photographic Printing Paper.* **L. A. Jones.** (Eastman Kodak Co. Research Lab. Comm. No. 264. Frank. Inst., J. 204. pp. 41–89, July, 1927.)—This is the fifth in a series of papers [see Abstract 1730 (1927)]. The following are the principal points considered under the main heading, "Correlation between sensitometric constants of positive materials and the characteristics of the optimal positives and negatives." General review of tone reproduction theory with application to a specific case. Summary of data available for use in correlation. The expression of experimental errors in terms of the Bravais-Pearson coefficient. The correlation between the limiting gradient (minimum gradient) of reproduction, $e\theta_r$, and the density scale of optimal positive DS_p. Correlation between the limiting gradient of the reproduction and the maximum gradient of the reproduction, γ_r. Correlation between the equalised limiting gradient of the optimal positive, $e\theta_p$, and the maximum gradient of the positive, γ_p. Variation in gradient of optimal negatives, ϕ_n, for groups of positive material equal with respect to (*a*) exposure scale, ES_y; (*b*) mean gradient, ϕ_y; and (*c*) density scale, DS_y. An erratum relative to section B of this series is given on p. 89. A. E. G.

2880. *Fluorescence and Phosphorescence.* **S. I. Wawilow** and **W. L. Lewschin.** (Zeits. f. Physik, 44. 6–7. p. 539, 1927.)—In their previous work [see Abstract 1319 (1926)] the authors accept Gaviola and Pringsheim's results [see Abstract 2503 (1927)]. Solid uranium salts give no fluorescence, while all the other phosphors tested do so. A. D.

2881. *A Consequence of the Analogy between the Light Quantum and the Electron.* **G. Beck.** (Zeits. f. Physik, 43. 9–10. pp. 658–674, 1927.)—The paper shows the consequences of postulating the analogy between radiation and matter. It is shown that optical laws can be regarded as the limiting case of general electrical relationships. It is further sought to show that, on the basis of the conception of quantum mechanics, it is possible to substitute for the conception of the field in electrodynamics a statical condition which is described. The paper deals with refraction, interference, polarisation and other optical phenomena. S. G. B.

2882. *Light Emitted by a New Model of the Mercury Arc in a Quartz Envelope.* **A. Bonnichon.** (Rev. d'Optique, 6. pp. 268–274, June–July, 1927.)—For the tests a Fabry Perot interferometer was employed. A parallel beam of light from the source passes through a direct vision prism and is then focussed to give a pure spectrum. The selected radiation passes through a slit and is finally received on a photographic plate. The brightness of the rings is examined by a process of photographic photometry and can be decided to 1 %. The rays from a Cooper-Hewitt lamp give one principal and two feebler sets of fringes. With a quartz envelope two sets of equal brightness and one fainter are obtained. By heating the envelope externally the rings become brighter but are less sharp, although still distinct. The effect of the self-induction in the electric circuit of the arc was examined. R. S. R.

2883. *Production of a Pure Spectrum by Means of the Boundary Line of Total Reflection.* **R. Richter.** (Zeits. Instrumentenk. 47. pp. 357–359, July, 1927.)—A method was indicated by Kohlrausch of determining the refraction of a glass prism on the spectrometer with a glancing ray of light, but it was pointed out by Martens [Abstract 1283 (1901)] that this method has the disadvantage of not resolving closely packed lines. Pulfrich improved on it by inserting between the luminous source and his refractometer a notched screen, in order to separate from each other the boundaries of total reflection of various spectral lines. Using sodium light, the visual field showed a luminous strip bounded on the one side by the limit of total reflection and on the other by the blurred image of the screen. The author repeated the experiment but used a straight edged screen with a fine adjustment, enabling its distance from the plane of the prismatic face to be varied. When the screen was slowly moved towards the plane of the prism the luminous slit in the telescope became very narrow and finally resolved itself into two fine bright strips, the edges of which were the boundaries of the two D lines. A sketch of the apparatus is given. E. F.

2884. *Mean Life Period from Resonance Phenomena.* **E. Fues.** (Zeits. f. Physik, 43. 9–10. pp. 726–740, 1927.)—For atoms having several similar electrons, states of excitation are possible which have the same energy as that of the corresponding ions, so that the probability arises of the atoms spontaneously reaching the latter configuration. This transition may be followed by wave mechanics, and in this way the mean life period for the first state and the probability of the transition may be calculated. By comparison with the probability of a transition to the unexcited state with the emission of a light quantum, the order of magnitude of the quantity of fluorescent energy re-emitted may be found. The influence of the spontaneous transition on dispersion is also discussed. W. V. M.

2885. *Resonance Radiation from Electrically Excited Argon.* **K. W. Meissner.** (Zeits. f. Physik, 43. 7. pp. 449–453, 1927.)—Two tubes were employed, one, A, cylindrical, with transparent plane ends, and the other, B, a thin one, bent into a zigzag form so as to surround A on three sides. Light from B passes into A, the radiation from which passes into the spectrograph. Observations were made with the same current passing through A alone, *a*, and through A and B in series, *b*. The difference between spectra *a* and *b* is due to the excitation of argon atoms in A by the light from B. The intensity of many of the lines is greatly increased, others are not affected. The strengthened lines are all combinations $2s_i - 2p_k$. A table gives the terms, wave-lengths and intensification of the lines in question; certain theoretical difficulties in explaining the results are pointed out, and the necessity, for a complete explanation, of further experiments using monochromatic light is insisted on. H. N. A.

2886. *The Under-Water Spark Spectra of Certain Elements.* **Elizabeth J. Allin** and **H. J. C. Ireton.** (Roy. Soc. Canada, Trans. 21. Sect. 3. pp. 127–131, March, 1927.)—The paper contains experimental values of the absorption lines of beryllium, gold, molybdenum, tantalum and tungsten. W. V. M.

2887. *Origin of the Auroral Green Line in the Oxygen Spectrum.* **J. C. McLennan, R. Ruedy** and **J. H. McLeod.** (Roy. Soc. Canada, Trans. 21. Sect. 3. pp. 27–31, March, 1927.)—In seeking to fit the auroral green line λ5577·341 Å. observed in the spectrum of oxygen into the system of energy levels provided for atoms of this element both forbidden and permissible transitions must be carefully scrutinised. The examples of mercury and iodine are discussed in detail. W. H. Ge.

2888. *Structure of the Arc Spectra of the Elements of the Nitrogen Group.* **J. C. McLennan** and **A. B. McLay.** (Roy. Soc. Canada, Trans. 21. Sect. 3. pp. 63–77, March, 1927.)—It is shown that, from the available data, the structures of the arc spectra of N I, P I, As I, Sb I and Bi I, as far as certain of the most stable energy states are concerned, can be developed along the lines of the Pauli-Heisenberg-Hund theory. For the singly ionised atoms N II, P II, etc., in the stable state, the outer electrons are arranged two in the n_1 and two in the n_2 levels, where n is 2, 3, 4, 5 and 6 for the five elements. In the first state, *a*, of the four most stable configurations of the five outer electrons of the neutral atom there are two in n_1 and three in n_2; in state *b* there are two in n_1, two in n_2 and one in $(n + 1)_1$; in *c* two in n_1, two in n_2 and one in n_3; in *d* two in n_1, two in n_2 and one in $(n + 1)_2$ except in the case of nitrogen. State *a* is that of the unexcited unionised atom of each element, and *b* the most stable of the excited states. Terms of the type $^4S_2$, $^2D_{23}$, $^2\bar{P}_{12}$, and $^4P_{123}$, $^2P_{12}$ have been identified. The first, second and third of these are the deep ones of each spectrum, with $^4S_2$ the deepest. The terms $^4P_{123}$ and $^2P_{12}$ are the most important of the higher energy terms, the first being deeper than the second. H. N. A.

2889. *Excitation of the Spectra of Carbon Monoxide by Electronic Impacts.* **O. S. Duffendack** and **G. W. Fox.** (Astrophys. J. 65. pp. 214–237, May, 1927.)—The ionisation potential of the carbon-monoxide molecule was determined with the low-voltage arc to be 14·3 volts. The band spectra of carbon monoxide were excited in tubes with two and three electrodes, and the excitation potentials for the various systems were determined by the photographic method. Two parallel sets of levels occur for the neutral molecule with values 6·0, 10·34, 11·35 volts for one set and 8·0 and 10·73 volts for the other set. The systems have been correlated to transitions between these levels. The third positive carbon bands reported by Deslandres have been shown to be due to carbon monoxide. Complete analysis of the third positive system has been made, and a new system proposed. The ionised carbon-monoxide molecule was found to have three levels with values 16·9, 20·0, and 22·9 volts. The systems of negative bands have been correlated to transitions between these levels. AUTHORS.

2890. *Excitation by High-Velocity Electrons.* **E. G. Dymond.** (Cambridge Phil. Soc., Proc. 23. pp. 804–810, July, 1927.)—The form of the excitation function for velocities much above the minimum required for excitation is in considerable doubt, and the method of Hughes and Lowe [see Abstract 267 (1924)] is open to objection because it is necessary to assume that the light is caused only by electrons of the known impressed velocity and that there are no secondary effects; also that the current density does not vary in the observational space. The author has repeated the experiments, using a form of incandescent kathode source which with high potentials gives a sharply defined beam of electrons. It is possible, using this, to eliminate the effect of secondary excitation. The variation in intensity of the helium lines is shown by means of curves; no systematic difference in behaviour between the lines of the single and triplet systems is to be noticed except for line 4713. Hughes and Lowe found in the region of lower velocities that the intensity of the triplet (orthohelium) system fell off more rapidly. The theoretical curve of Born gives the general tendency of the function, but not a very satisfactory fit. The author discusses the theory, and suggests that when an atom is struck by a fast electron the radiation emitted is not due to quantised excitation, but is of the nature of a radiation of recombination during the act of ionisation, in a manner the possibility of which has been pointed out by Franck. H. N. A.

2891. *Absolute Intensities in the Hydrogen-Chloride Rotation Spectrum.* **R. M. Badger.** (Nat. Acad. Sci., Proc. 13. pp. 408–413, June, 1927.)—The pure rotation spectrum of hydrogen chloride, recently determined in absorption by Czerny [see Abstract 96 (1926)], was used by Tolman and Badger [see Abstract 1820 (1926)] for the calculation of integral absorption coefficients and then for the determination of the experimental B_{ij}'s or the probabilities of transition from one energy state of rotation to the next higher in the presence of radiation which may be absorbed. Since, however, this spectrum was investigated with a spectrometer of not very great resolving power, the process may have led to somewhat inaccurate results. In the present paper new experimental measurements on the same spectrum are described together with an improved method whereby they are used to determine absolute absorption coefficients. H. H. Ho.

2892. *Line Intensities in the Hydrogen Chloride Fundamental Band.* **D. G. Bourgin.** (Phys. Rev. 29. pp. 794–816, June, 1927.)—The transmission of columns of HCl 0·0998, 0·169, 0·248, 0·54, 0·996 and 2·97 cm. long in the region of its fundamental vibration-rotation band at 3·5 μ was measured with a bismuth-silver vacuum thermopile. The curves give indirect evidence of the isotopic doubling and yield fairly accurate absolute and relative values of the intensities of the absorption lines. The results confirm the predicted asymmetry in the intensities of the P and R branches, the summation rule, and the new formulation of the quantum theory. The particular choice of statistical weights favoured is the selection $p_m = 1, 3, 5, \ldots$ if the lines are singlets, and $p_m = 2, 4, 6, \ldots$ if spectroscopic doublets. It is demonstrated that the exponential law of transmission is not applicable to the transmission curves. The calculated values of the Einstein probability coefficients are $B_{0,1} = 5 \cdot 1 \times 10^{15}$ for the first line of the positive branch and $A_{0,1} = 58$ for the first line of the negative branch, while the most plausible value of the variation of the molecular moment with nuclear displacement as determined for the region of the equilibrium position is $0 \cdot 828 \times 10^{-10}$ c.s.u. W. V. M.

2893. *Structure of the Second Order Spectrum of Carbon* (C_{II}). **C. Mihul.** (Comptes Rendus, 184. pp. 1648–1649, June 27, 1927.)—Reference is made to Bowen's identification of two terms giving in the extreme ultra-violet a triplet. The author has identified three other multiple terms: a triplet $^4P^4S$, a multiplet $^4P^4P'$, and a multiplet $^4P^4D$. The probable electronic configuration for these terms is deduced according to Hund's theory. R. S. R.

2894. *Band Groups and Absorption Heads Series in Earth Alkali Phosphors.* **F. Schmidt.** (Ann. d. Physik, 83. 2. pp. 213–246, June 8, 1927.)—The writer points out that different metals in similar alkali sulphides and oxide bases have common "absolute" wave-lengths of excitation (d bands). There appear to be five different d band groups ("Bandenarten"). The fact that different metals may have common d bands, and the same metal several different excitation groups, is attributed to the similarity or difference of the binding of the active metal to the S or O. It is shown how the absolute d values are the absorption heads, which can be arranged in a series of the form $\nu = K(1/n^2 - 1/D^2)$. Experimental work is described on the preparation of different phosphors and the determination of the dielectric constants. Finally, exact series are given for the different types of bands so far observed, and a relation is established between the principal band group (No. 2) and the so-called "heat" band group. J. E.

2895. *Band Spectra. Part II.* **R. Mecke and M. Guillery.** (Phys. Zeits. 28. pp. 479–492, July 1, and pp. 514–531, July 15, 1927.)—This paper refers to an earlier *résumé* [see Abstract 1369 (1925)], confining itself to a synopsis of the heavy literature on band spectra from the beginning of 1925 to April, 1927, and treats of the general theory on the subject, the energy of dissociation of the molecule, intensity distribution in band spectra, the effect of isotopes and experimental data. Reasons are given why no further summary upon the Zeeman effect is included. A comprehensive bibliography of 266 references is given.

J. K.

2896. *Structure of NO Bands.* **Maria Guillery.** (Zeits. f. Physik, 42. 2–3. pp. 121–145, 1927.)—The spectrum of the NO bands, excited by a discharge in a vacuum tube, is photographed and the bands analysed into series. A. C. M.

2897. *Zeeman Effect and Spherical Harmonics.* **C. G. Darwin.** (Roy. Soc., Proc. 115. pp. 1–19, June 1, 1927.)—Presents a simple system of equations for finding the frequencies and intensities in the standard Zeeman effect. Previous formulæ are valid only either in weak or in strong fields, except for doublets, but from the new formulæ the intensities can be found for all cases in any field. The equations are obtained by the development of the theory of an avowedly rather crude model, consisting of a charged spinning spherical body moving in a central field of force, which, however, gives all the observed results. The development is in the form of tesseral spherical harmonics. The law of combination of the quantum number j is rather concealed, but a different development is sketched which brings out the meaning of j with full force. The model only yields strictly the odd multiplicities, but the same system of equations will also give the even ones. Some examples are worked out. The meaning of the quantum numbers k, m, r, m_k, m_r are strongly brought out; j is the rank of the tensor solution and has only a real meaning in the absence of the external magnetic field. H. N. A.

2898. *Zeeman Effect in Tungsten.* **H. Beining.** (Zeits. f. Physik, 42. 2–3. pp. 146–159, 1927.)—The tungsten spectrum in the region 2600–5800 Å. is studied, using a field strength of 30,000 gauss. Laporte's finding of PD multiplets in the arc spectrum is confirmed, and also his observation that SP combinations are not known. The investigation shows that the g-values of Landé agree in none or only very few cases. A. C. M.

2899. *Arc Spectrum of Tin and the Zeeman Effect.* **E. Back.** (Zeits. f. Physik, 43. 5–6. pp. 309–320, 1927.)—The empirical estimation of the splitting factor g and the inner quantum number j makes it possible to arrange the early members of the p, s, and d terms in accordance with Hund's scheme. A. C. M.

2900. *An Objective Demonstration of the Zeeman Effect.* **K. W. Meissner.** (Zeits. f. Physik, 43. 7. pp. 454–455, 1927.)—Two neon tubes are employed, A and E, a Nicol prism, a system of lenses, a slit, and a screen. E is the emission tube, light from which passes through the Nicol and the tube A, and falls on the screen. A is placed between the poles of an electromagnet. Without a magnetic field and with current through A, when the Nicol is in a certain position, the spot on the screen is less bright than when there is no current; when the magnet is excited there is no difference in the two intensities. The wave-length of the vibrations in tube A is altered by the field, so that the excited neon in it no longer absorbs the light from E. The experiment can be seen by a large audience. H. N. A.

2901. *Fine Structure and Arrangement of Terms of the Bismuth Spectrum.* **S. Goudsmit and E. Back.** (Zeits. f. Physik, 43. 5–6. pp. 321–334, 1927.)—From the fine structure of bismuth lines there can be obtained a number of term separations, which make an adequate confirmation of the arrangements of terms of Bi by Thorsen. A theoretical consideration of the probable origin of the lines of the fine structure and their connected quantum number is based on the empirically estimated term separations. A. C. M.

2902. *The Ionisation Potential and the Multilinear Spectrum of Hydrogen.* **K. F. Niessen.** (Zeits. f. Physik, 43. 9–10. pp. 694–706, 1927.)—It is shown that the consideration of half-quantum numbers in connection with the hydrogen molecular ion affords the value 15 volts for the ionisation potential of the gas, and that part of the hydrogen multilinear spectrum probably originates in an excited molecule containing such an ion. J. S. G. T.

2903. *The Number of Radiating Atoms in a Hydrogen Discharge Tube.* **W. H. Crew and E. O. Hulburt.** (Phys. Rev. 29. pp. 843–847, June, 1927.)—About 90 % of the energy radiated from a long hydrogen tube filled with moist hydrogen at a pressure of 0·54 mm. of mercury and absorbing 400 watts was found to be carried by the first three lines of the Balmer series. From the measured values of this energy and of the relative intensities of Hα, Hβ and Hγ, the number of quanta of these lines emitted per atom per second was calculated to be 2·84, 0·43 and 0·10 respectively. AUTHORS.

2904. *The Doppler Effect in Hydrogen Canal Rays and the Balmer Series.* **W. Steubing.** (Ann. d. Physik, 83. 6. pp. 822–834, July 20, 1927.)—An experimental investigation of the stationary and movable intensity lines due to Stark. It is shown that small quantities of helium, neon and mercury vapour, as also certain paraffins, give no different phenomena from pure hydrogen, but oxygen and nitrogen present do affect the results. The paper is illustrated by curves, and full experimental details are given. The discussion is also directed towards the Balmer series, and the ratio $\frac{\text{stationary}}{\text{movable}}$ intensity is defined and evaluated.

S. G. B.

2905. *Molecular Spectra of Potassium, Sodium and K-Na Alloy.* **P. Pringsheim** and **E. Rosen.** (Zeits. f. Physik, 43. 8. pp. 519–523, 1927.)—The band spectrum of potassium was excited by the resonance line of zinc 6362 Å. The scheme of levels for the potassium molecule is then given. The frequencies of nucleus of K and Na are inversely proportional to their atomic numbers. The corresponding frequency for the resonance spectrum of K-Na is a mean of the values for K-Na. F. S.

2906. *Spectra of Metals of Group II.* **M. Saha.** (Phil. Mag. 3. pp. 1265–1274, June, 1927.)—In the paper an extension of the principles of non-mechanical vector addition of quantum numbers for finding out all the terms above the fundamental levels of the atom and, in the case of metals of the second group, all details of their spectra are explained satisfactorily. A complete structure diagram is included, and the rules of addition of quantum numbers are summarised. The chart illustrating periodic classification and electronic composition of atoms is a modification of the earlier schemes of Bohr and Stoner. It explains the formation of (1) the regular groups, (2) the transitional groups, (3) the rare earths, and gives the electronic composition of the outer shells of electrons, as obtained from Hund's interpretation of complex spectra. R. S. R.

2907. *Explanation of the Spectra of Metals of Group II. Part II.* **P. K. Kichlu** and **M. Saha.** (Phil. Mag. 4. pp. 193–207, July, 1927.)—Numerous groups of dashed and barred terms have been identified in spectra by Russell and Saunders and by Wentzel, who stated these were probably due to the stationary electron existing in the metastable M_3 level. The facts obtained by Bowen and Millikan by the hot-spark method and other details of Russell and Saunders obtain a unitary explanation on the lines of an earlier paper by the second author [see preceding Abstract]. The authors set out the structure diagrams for Mg, Ca, Zn and Cd. The combination rules of Pauli, Heisenberg and Hund are applied to obtain the probable anomalous terms in the spectra of Mg, Zn, Cd, Ca, Sr and Ba, and these confirm the assumptions of Russell and Saunders and of Wentzel on the nature of the dashed or barred terms. R. S. R.

2908. *Fine Structure of the Spectrum Lines of Cadmium in the Ultra-Violet.* **W. Mohammad** and **S. B. L. Mathur.** (Phil. Mag. 4. pp. 112–120, July, 1927.)—The authors have made an attempt to investigate the structure of the most prominent cadmium lines between 4800 and 2775. They find that their results generally are in fair agreement with those of MacNair [see Abstract 122 (1927)]. Further results are to be communicated. J. E.

2909. *Origin of Terms in the Spectrum of Cobalt.* **N. K. Sur.** (Phil. Mag. 4. pp. 36–49, July, 1927.)—A brief sketch is given of Saha's method of distributing the electrons in the atoms of the different elements of the periodic table, and it is shown how the electron scheme of any atom is

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used in identifying the terms forming a Rydberg sequence. The origin of terms in the spectrum of cobalt is then discussed in detail. It is pointed out that in the analysis of the arc spectrum of cobalt, as yet only a number of fundamental levels and some levels combining with these have been found, no Rydberg sequence having been discovered. *Addendum.*—The results of further analysis leading to the identification of the Rydberg sequence will be published in a separate paper. W. S. S.

2910. *Spectrum of* $Si^{+}II$. **P. K. Kichlu.** (Optical Soc. America, J. and Rev. Sci. Inst. 14. pp. 455–459, June, 1927.)—After a reference to previous work by A. Fowler and by M. N. Saha on the spectrum of Si and similarity with that of Al, the author develops an electronic configuration in an atom of singly ionised Si according to Saha's scheme. This brings out the energies of the electrons in the different states, and in a table the term designation and term values of Al and $\mathrm{Si}^{+}/4$ are set out. He suggests that the region containing the lines $^{2}\mathrm{P} - {}^{4}\overline{\mathrm{P}}$ at about λ2500 requires further investigation by the electron bombardment or the vacuum arc method, the potential for the former lying between 16 and 20 volts. R. S. R.

2911. *Bead Spectra.* **H. L. Howes** and **M. K. Slattery.** (Optical Soc. America, J. and Rev. Sci. Inst. 15. pp. 17–24, July, 1927.)—By the use of double fluxes instead of single fluxes an attempt was made (*a*) to better the resolution and (*b*) to increase the intensity of the transformation spectra of several elements. These objects were partially attained, and the principle of essential identity, as applied to this type of spectrum, was substantiated. AUTHORS.

2912. *Note on the Spectrum of Neon.* **M. Saha.** (Phil. Mag. 4. pp. 223–231, July, 1927.)—The complicated spectrum of neon is very simply explained in the recent theories of complicated spectra. The theory accounts for not only the fundamental levels, but also for all the higher levels, the Rydberg sequences, and the order of values observed in each case. It also gives an explanation of the origin of the dashed terms, and explains such transitions as apparently break the selection principle, *e.g.*, $\Delta K = 2$ or 3. J. E.

2913. *Band Spectrum of Water Vapour.* **D. Jack.** (Roy. Soc., Proc. 115. pp. 375–390, July 1, 1927.)—Experimental work on the spectrum of water vapour is described, and in particular details are given of the band λ2608. This is shown to have the same structure as the bands 3064, 3122, 2811, and 2875, and to lead to the same final value for the moment of inertia as the bands 3064 and 2811. Dieke's scheme for these bands is verified and extended, and measurements by Tanaka on the band 3428 are shown to fit in the scheme. The doublet formation in the bands, in terms of the Kratzer-Kramers and Pauli expression, is discussed. The available evidence on the nature of the emitter of the water-vapour bands is shown to be in favour of the OH ion.
W. S. S.

2914. *Effect of Chemical Combination on X-Ray Absorption.* **W. B. Morehouse.** (Phys. Rev. 29. pp. 765–774, June, 1927.)—The X-ray absorption by aqueous solutions was measured before and after chemical reaction, employing a differential null method similar to that described by Becker [see Abstract 170 (1923)]. Direct and zirconium filtered beams from a water-cooled molybdenum Coolidge tube, operating at 30-kV peak, were used. Cells having equal compartments were used, so that the same elements were in the beam before and after combination. Measurements were made on the following reactions :—

(A) $KI + I_2 + 2Na_2S_2O_3 \rightarrow KI + 2NaI + Na_2S_4O_6$.
(B) $K_2Cr_2O_7 + 12KI + 14HCl \rightarrow 8KCl + 2CrCl_3 + 3I_2 + 6KI + 7H_2O$.
(C) $NaOH + HCl \rightarrow NaCl + H_2O$.
(D) $KOH + HCl \rightarrow KCl + H_2O$.
(E) I_2 in 70 % alcohol + $2Na_2S_2O_3 \rightarrow 2NaI + Na_2S_4O_6$.

Corrections having been made for changes in density, the results indicate : Reaction (A) ; the mass absorption coefficient for the solution after reaction for the direct beam approximately 0·24 % less than before reaction ; for the filtered beam 0·36 % less. Reaction (B) ; direct beam ; 0·25 % greater. Reaction (C) ; direct beam ; no appreciable change. Reaction (D) ; direct and filtered ; no appreciable change. Reaction (E) ; direct beam ; 0·36 % less. The results indicate that the mass absorption coefficient for an element depends upon its valence or state of chemical combination. Since iodine, sulphur and chromium are the only elements changing valence, and since computations from known absorption coefficients show that the absorption by the iodine in the beam is several times that by either the sulphur or the chromium, it seems probable that the absorption by iodine in the free state is greater than its absorption in the combined state. AUTHOR.

2915. *Measurements on the Absorption of X-Rays of Long Wave-Length.* **L. H. Martin.** (Cambridge Phil. Soc., Proc. 23. pp. 783–793, July, 1927.)—Preliminary measurements of the mass absorption coefficients of Fe, Ni, Cu and Al have been made over the range 0·705 Å. to 1·932 Å. In this range the scattering absorption can be neglected in investigating the relationship between the "true" or "fluorescent" mass absorption coefficient and the wave-length of the absorbed radiation. The results are compared with those of Barkla and Sadler and of S. J. Allen, and are discussed in relation to the theoretical work of Wentzel, of de Broglie, of Kramers, and of Bothe.

An interesting method of obtaining the action of thin foils was used, in which a thicker foil was mounted on the moving arm of a divided circle ; a measurement was first made with the foil perpendicular to the beam, and a second when it was turned through a measured angle. The effective thickness was then $d = D(\sec. \theta - 1)$, where D is the real thickness. H. N. A.

2916. *Energy Measurements with X-Rays.* **W. Rump.** (Zeits. f. Physik, 43. 3–4. pp. 254–295, 1927.)—After an historical and critical introduction on methods of measurement hitherto in use, a calorimeter is described for measuring the heat effect of X-rays. This is built on the principle of the black-body radiator. With its help the relation between the output of a tube and the voltage, between 43–150 kV, is determined. It appears that the total energy radiated depends on the square of the voltage. The X-ray energy output is also compared with the calorimetrically measured energy of the kathode-ray stream, and the efficiency is found to be from 0·5 to 1·5 % (considerably higher than previously assumed). Also by comparison with calorimetrically measured X-ray energy and the ionisation effect with different qualities of rays is found the energy necessary to produce a pair of ions. With hard rays, well filtered, it takes 40 volts per ion pair, and this is probably constant for wave-lengths between 0·43 and 0·12 Å.U. A very full list of references is given. **Errata** (*ibid.* 44. 4–5, p. 396, 1927).—New measurements in the Phys. Techn. Reichsanstalt show that the R values used above were 20 % too high. Recalculation shows now that only 33 volts per ion pair are required in the above range, in good agreement with Kulenkampff. J. E.

2917. *Röntgen-Ray Investigations on Inorganic Colloids.* **J. Böhm.** (Kolloid Zeits. 42. pp. 276–284, July, 1927.)—The Röntgen-ray diffraction spectra of various colloids were examined and compared with the diffraction spectra of the same elements in the massive state and as powders. The substances examined were colloidal Fe_2O_3 in the form of a naturally occurring mineral, and a simple fibrous structure was found. Colloidal gold in the form of " purple of Cassius " was compared with spongy gold prepared by precipitation, or by dissolving a zinc-gold alloy, which yielded an extremely fine precipitate. The gels of stannic oxide were compared with the massive form, and the sol of vanadium pentoxide was examined by the same method. F. J. B.

2918. *The Amount of Silver Separated from Silver Bromide by a Quantum of X-Radiation.* **J. Eggert and W. Noddack.** (Zeits. f. Physik, 43. 3–4. pp. 222–229, 1927.)—The quantum equivalent was determined by measuring the energy of the X-radiation, the absorption in the photographic film and the amount of silver formed. For small amounts of radiation (the photographic region) the number of the developable grains was compared with the number of quanta (energy $h\nu$) of X-radiation absorbed. About 1000 silver atoms were separated per quantum when λ was equal to 0·45 Å. It has previously been shown that in the case of light, $\lambda = 4358$ Å., about one atom of silver is separated per quantum. Each absorbed quantum of X-radiation makes one silver bromide grain capable of development. It is also shown that, when a film of calcium tungstate is used to intensify the action of X-rays on a photographic plate, each $h\nu$ of X-radiation produces at least 30 $h\nu$ of blue fluorescent light. **Errata** (*ibid.* 44. 1–2. p. 155, 1927.) H. N. A.

2919. *Heat Energy of X-Rays.* **R. Kegerreis.** (Phys. Rev. 29. pp. 775–781, June, 1927.)—Efficiency of a tungsten-target Coolidge X-ray tube operated at peak voltages from 100 to 200 kV.—The efficiency of X-ray production was experimentally determined for voltages between 100 and 200 kV. The high-voltage energy input into the X-ray tube was measured by means of an absorption calorimeter. The intensity of the X-rays was measured by means of the temperature-rise of a lead absorption cup arranged so that the effects due to scattering and fluorescence of the X-rays as well as effects due to external temperature conditions were eliminated. Elaborate precautions were also taken to suppress electrostatic and electromagnetic induced effects from the high-voltage circuits. The efficiency was found to be proportional to the peak voltage. The factor of proportionality was 0·0032 when the efficiency is expressed as a percentage and the peak voltage in kilovolts. AUTHOR.

2920. *Thermal Effects on X-Ray Spectra.* **I. Waller.** (Ann. d. Physik, 83. 2. pp. 153–183, June 8, 1927.)—A theoretical paper on the influence of the thermal agitation of the atoms in a crystal lattice on the intensity, position and sharpness of X-ray spectral lines. W. H. GE.

2921. *Absolute Measurements of the Number of Quanta in a Röntgen Beam.* **W. Kossel** and **M. Steenbeck.** (Zeits. f. Physik, 42. 11–12. pp. 832–834, 1927.)—The method of measuring the absolute intensity of an X-ray beam by the number of photoelectrons ejected by it in a known space has been described in a previous paper [see Abstract 873 (1924)]. The present paper describes a new method free from the theoretical objections of the above. A Geiger "point" ionisation chamber is used. The beam is sent along between the plates of a condenser. Below a variable opening in the lower plate the point is placed so as to collect the ions formed in a cylinder with the opening as base. The sensitiveness is some million times as great as the Kulenkampff thermal method [see Abstract 1357 (1926)]. For CuKα it is found that 29·7 volts are required per ion pair. The method is being simply extended. J. E.

2922. *Theory of the Intensity of Scattered X-Rays.* **G. E. M. Jauncey.** (Phys. Rev. 29. pp. 757–764, June, 1927.)—Williams [see Abstract 702 (1927)] has extended the writer's theory of the unmodified line in the Compton effect [see Abstract 1670 (1925)] to the case of the reflection of X-rays by crystals. It is assumed by both that it is the U-electrons (electrons associated with unmodified scattering) which take part in crystal reflection. It is now assumed that the U-electrons scatter coherently and according to the classical theory; in modified scattering the S-electrons (electrons associated with modified scattering) are supposed to scatter incoherently and according to the quantum theories of Compton, Jauncey and Breit. Formulæ are obtained for the energy of the total scattering coefficient and for the ratio of the modified to the total scattering coefficient. A. C. M.

2923. *"J" Phenomenon.* **B. L. Worsnop.** (Phys. Soc., Proc. 39. pp. 305–312; Disc., 312, June, 1927.)—Experiments extending over several months and in which a "balance method" has been used have failed to obtain the "J" discontinuity found by Barkla in heterogeneous X-rays scattered by elements of low atomic weight. It is suggested that some condition not yet published is required for the production of the phenomenon, and further work is promised. In the *Discussion,* **E. A. Owen** stated he had found no evidence of discontinuity on measuring the variation in intensity along the shadow of a wedge, and had abandoned the work under the impression that some requisite experimental condition had been missed. W. H. GE.

2924. *A Model Illustrating the Laue Effect.* **G. B. Hagen.** (Phys. Zeits. 28. pp. 453–455, June 15, 1927.)—Employs a number of small mirrors, mounted in such a way that, when the model is placed in a slightly diverging beam of light, they reflect on to a screen a number of small light spots which lie on circles, as do the spots of a Laue diagram. H. N. A.

2925. *Directional Distribution of Electrons Produced by Polarised X-Rays.* **F. Kirchner.** (Ann. d. Physik, 83. 4. pp. 521–534, June 28, 1927.)—A continuation of previous experiments of the directional distribution of electrons emitted under the action of X-rays [see Abstract 1412 (1927)]. The azimuthal distribution of the electrons was investigated by means of stereoscopic photographs, the ionisation being produced by X-rays from a Coolidge tube run at 30–50 kV without a filter in the gases CO_2, N_2, and A in turn. The distribution of the photoelectrons is found to be independent of the wave-length of the incident radiation over the region 0·3 to 0·5 Å. and also unaffected by the type of gas ionised, or the atomic number, or work required to ionise the scattering atom. The distribution is approximately a $\sin^2 \theta$ arrangement, thus confirming the hypothesis of Auger and Perrin and the deductions from wave mechanics. The sources of error involved in the evaluation of the distribution are considered, more particularly certain subjective errors. The validity of Whiddington's law, $V_{kv} = \text{const.} \sqrt{R}$ (where V_{kv} is the initial energy of the electron in kilovolts and R the length of track), is discussed and the value of the constant found to be 22·6 for argon, while Nuttall and Williams obtained 24·8. The values obtained for the length of track are in agreement with the supposition that its value is inversely proportional to the number of electrons in the molecule. W. V. M.

2926. *X-Ray Diffraction in Liquids.* **C. M. Sogani.** (Indian Journ. of Physics, 1. pp. 357–392, June, 1927.)—Previous experimental work summarised, and theories reviewed. Improvements in technique described; 22 aliphatic and aromatic liquids examined. The agreement obtained in a few cases byKeesom and Smedt between Ehrenfest's formula and the mean molecular distance as calculated on the assumption of hexagonal closest packing in the liquid is purely accidental; the value of Bragg's ratio *k* departs more and more from that corresponding to close packing as the length or asymmetry of the molecule increases. The influence of compressibility on the sharpness of the halo (Raman and Ramanathan) is confirmed. The scattering at small angles is not negligibly small, and is relatively greater in the case of liquids with higher compressibility or having comparatively unsymmetrical molecules. The halo is progressively modified as we pass to more and more complex derivatives and differs distinctly even between isomeric molecules; further experiments are in progress which may throw light upon the cause of this dependence on the molecular structure. A. D.

2927. *Efficiency of the K-Series Emission by K Ionised Atoms.* **L. H. Martin.** (Roy. Soc., Proc. 115. pp. 420–442, July 1, 1927.)—Describes experiments in which the characteristic K-series radiations have been excited in Fe, Ni, Cu and Zn, using exciting radiations varying from 0·6 Å. to the K limit. The efficiency ϕ of the K emission was determined by an ionisation method, and found to be low, in agreement with the results of other observers. This is explained by means of the hypothesis that the excited K radiation does not in all cases escape from the atom, but is internally absorbed in outer electron shells, from which, as a result, high-speed electrons are ejected. The probability of the K-series emission, as opposed to this internal absorption, is found to be independent of the frequency of the exciting radiation. The efficiency ϕ is a function of the atomic number, and it seems probable that the laws connecting the probability of absorption with atomic number and wave-length are similar for normal and internal absorption. H. N. A.

2928. *Production of Characteristic X-Rays by Electronic Impact.* **L. H. Thomas.** (Cambridge Phil. Soc., Proc. 23. pp. 829–831, July, 1927.)—Discusses Rosseland's theory [see Abstract 687 (1923)]. Taking into account the velocity of the core electron in its orbit and the increased velocity of the impinging electron due to the atomic field considerably alters Rosseland's formula. The new formula fits the experimental results (Wooton's) better than Rosseland's for the Kα line of molybdenum. A. D.

2929. *Theory of the Compton Effect.* **G. Wentzel.** (Zeits. f. Physik, 43. 11–12. pp. 779–787, 1927.)—A continuation of work previously described [see Abstract 2552 (1927)]. From a consideration of inner atomic interference a more accurate estimate of the intensity of the modified and unmodified lines is obtained. The method is also applied with some success to the maxima of the intensity of diffraction from rock-salt crystals. Fair agreement for angles of diffraction less than 50° is obtained. W. V. M.

2930. *The Spectrographic Junction of the X-Ray and Ultra-Violet Regions by Means of Ruled Gratings.* **J. Thibaud.** (Comptes Rendus, 185. pp. 62–64, July 4, 1927.)—Describes a vacuum spectrograph, using the method given in a previous paper [see Abstract 1430 (1927)]. It is arranged with a metal vacuum tube, with incandescent kathode for producing X-rays, which is joined by a conical joint to the spectrographic chamber, so that the whole space can be evacuated. In the previous apparatus this tube was replaced by an arrangement for producing condensed sparks. The grating in this instrument had 200 lines per mm., while the new one has 1180. The dispersion is large, and the X-ray lines are fine. The "wave-lengths" can be measured in Ångström units, the longest mentioned in the paper being that for Mα of molybdenum 65·0 Å. H. N. A.

2931. *Refraction of X-Rays.* **B. Davis.** (Frank. Inst., J. 204. pp. 29–39, July, 1927.)—An account of the author's investigations by two methods. The refractive index of a crystal may be found [Abstract 1047 (1926)] by grinding a crystal so that the ray enters at the correct angle for reflection very nearly parallel to the crystal face. The paper gives a series of measurements in pyrites. The theory of refraction indicates that the refraction should be much increased if the frequency of the incident radiation is near a resonance frequency of the refractor, and this was tested using CuKα having a frequency near that of the K level of iron. The results are in agreement with theory and the supposition that the K level contains two electrons. A double spectrometer also gave values in complete agreement with theory. The anomaly of the velocity of X-rays being greater than that of light in a crystal is an interesting case of the difference between wave and group velocity. The paper concludes with the experimental results obtained on passing X-rays through a block of graphite, and consequent widening of the refraction curves by refraction in the carbon particles. The theory was tested for the case of Al particles of known size, and the X-ray measurements confirmed the order of magnitude. The method should make it possible to measure the size of small particles far beyond the range of microscopic vision if the density and refractivity for X-rays in the solid form is known. W. V. M.

2932. *Emission of Soft X-Rays by Different Elements.* **O. W. Richardson** and **F. S. Robertson.** (Roy. Soc., Proc. 115. pp. 280–290, July 1, 1927.)—A continuation under improved conditions of previous work [see Abstract 1365 (1926)]. It is maintained that the efficiency of different elements as emitters of soft X-rays increases with the increasing atomic number far less rapidly than does the corresponding property for ordinary X-rays. The previous rule that the efficiency is proportional to the square root of this atomic number is now abandoned, and it is shown to be a periodic function, as are all other properties involving the loosely bound electrons. Experimental detail and results for a number of light elements are given. The experiments seem to suggest that either the X-ray quantum generated and the anti-kathode may have an energy comparable with that corresponding to the voltage on the tube, but that this may give rise to a number of electrons with lower energies rather than one with corresponding energy, or that the X-rays generated have a low average frequency compared to $\frac{eV}{h}$, where V is the voltage on the tube. W. V. M.

2933. *The X-Ray Spectrum of the Second Type.* **M. J. Druyvesteyn.** (Zeits. f. Physik, 43. 9–10. pp. 707–725, 1927.)—X-ray spectra of the second type are obtained from the inner layers of doubly ionised atoms. It is shown theoretically that the intensity of the spectrum of the second type is to that of the first type (or normal X-ray spectra) as the inverse square of the effective nuclear charge, a relation in complete agreement with experimental data. The probabilities of a number of transitions of electrons are calculated approximately, and also the values of the terms for the doubly ionised atoms. An experimental study of the $K\beta_1$ lines of the elements from K to Fe enabled these values to be checked. The satellite of $L\beta_2$ of a number of elements from ND(41) to Pb(82) were also investigated. The general agreement between theory and experiment is fairly close. W. V. M.

2934. *The Fundamental Law of the Physical Action of X-Rays of Various Wave-Lengths.* **R. Glocker.** (Zeits. f. Physik, 43. 11–12. pp. 827–838, 1927.)—The author suggests that a general law concerning the action of X-rays may be written action/electronic transformation × intensity = const. independent of wave-length, where by electronic transformation is meant the amount of energy from the incident X-rays transformed into the energy of moving electrons.

This equation is examined for the cases of ionisation of air, blackening of a photographic plate, production of optical fluorescence, alteration of resistance of selenium and conductivity of solid dielectrics under the action of X-rays. In each case an expression of the form given may be utilised. Thus it is shown that the essential factor in all these actions is the fraction of incident energy appearing in photo- and Compton electronic effects. The equation enables the effects to be calculated simply from a knowledge of chemical composition, absorption and scattering coefficients, geometrical and electronic coefficients. The results enable a measuring apparatus to be constructed using fluorescent screens or selenium cells which will be independent of wave-length within given limits. W. V. M.

RADIOACTIVITY.

2935. *Atomic Nuclei and their Transformations.* **E. Rutherford.** (Phys. Soc., Proc. 39. pp. 359–372, June, 1927.)—The first part of the lecture was mainly devoted to the scattering of α-particles by atoms, particularly by those of aluminium, helium, and hydrogen, and to the theories which have been put forward to explain the experimental results. It seems that the magnetic forces to be expected in the neighbourhood of a helium nucleus are of the right order of magnitude to account for the scattering observed. Puts forward a speculative theory of the nuclear structure of radioactive and of the other heavy elements. The central part of the nucleus is regarded as being a very compact structure with a radius of the order 1×10^{-12} cm. *Neutral* satellites circulate round this main nucleus, at some distance from it, under the attractive force of the main nucleus due to polarisation of the particles, or a magnetic force due to the main nucleus, or forces of both these kinds. The uncharged α satellite must consist of the helium nucleus with two electrons; these probably circulate in very close orbits, which are only possible owing to distortion of the α nucleus by the intense electrical or magnetic fields from the central nucleus. Neutral satellites of mass 2 or 3 may also exist. Isotopes of any element are supposed to have the same main nucleus with different satellites. The difference between the isotopic properties of even and odd elements is discussed from the point of view of the theory. H. N. A.

2936. *Disintegration of Elements by α-Rays. Part VI. The Disintegration of Carbon. Section II.* **H. Pettersson.** (Akad. Wiss. Wien, Ber. 136. 2a. No. 3–4. pp. 225–242, 1927.)—The author's first experiments on the subject were described in 1924, and he now deals with his own subsequent work and that of other observers. Those carried out by the scintillation method, with RaC and with polonium as source, prove that carbon is disintegrated. The advantages of polonium are explained and also the difficulties attending its use. The number of disintegration particles formed (H and possibly others) per million α-particles is at least sixty, and it has been shown that slow α-particles down to 2·2 cm. range are active. Experiments by Holoubek, using the Wilson cloud method, Kreidl with the Geiger point counter, Ortner and Stetter, who use a telephone with the counter, and Blau, who photographs the tracks of the H-particles, are mentioned. Stetter has made use of a special form of mass spectroscope to determine the mass of the particles, and has shown that at any rate the majority of them are protons. It seems certain that the carbon nucleus is not composed of three α-particles. H. N. A.

2937. *Disintegration of Elements by α-Rays. Part V. Disintegration Products of Short Range.* **G. Kirsch** and **H. Pettersson.** (Akad. Wiss. Wien, Ber. 136. 2a. No. 3–4. pp. 195–224, 1927.)—The authors have recently dealt with the subject in another publication along the same lines [see Abstract 2310 (1927).]. H. N. A.

2938. *Atomic Disintegration by α-Rays from Polonium.* **W. Bothe** and **H. Fränz.** (Zeits. f. Physik, 43. 7. pp. 456–465, 1927. From the Reichsanstalt.)—The elements from boron to calcium, with the exception of neon and argon, were tested with the α-rays from polonium, range

3·9 cm. A Geiger point counter was used to indicate the existence of products of atomic disintegration. The deflections of the electrometer were counted by two observers, and the advantages as compared with the scintillation method are pointed out. Only boron, nitrogen, magnesium, and aluminium show distinct evidence of disintegration by these slow α-rays. If the other elements send out any H-particles with more than 7 cm. range, the number must be considerably smaller than for the above four. The maximum range of the H-particles is in all four cases much smaller than in experiments with the faster X-rays from RaC.

H. N. A.

2939. *Vaporisation of Polonium.* **P. Bonèt-Maury.** (Comptes Rendus, 184, pp. 1376–1378, June 7, 1927). After referring to the work of M. Knudsen, I. Langmuir, and A. B. Wood on the vaporisation of radioactive substances, the author describes an investigation of the distribution of the vaporised material when polonium is heated in a high vacuum. It is shown that Lambert's cosine law holds in this case as in the case of light. A. B. W.

2940. *Vaporisation of Polonium.* **P. Bonèt-Maury.** (Comptes Rendus, 185. pp. 204–206, July 18, 1927.)—The author determined experimentally the distribution of condensed polonium around a sample of this substance, the experimental arrangements for which are given. The experimental results agree well with theory, departures from the theoretical curve not exceeding 2 %. The method supplies a very simple but relatively precise means of verifying the cosine law according to which the deposition of the polonium takes place. The author considers that the use of these atoms facilitates very much the solution of certain delicate problems in the kinetic theory, especially those concerning the reflection, condensation, and absorption of gaseous molecules. The research in this direction is being pursued further. R. S. R.

2941. *A Special Effect of Polonium, Solar Radiation and High Tension on Lead.* **(Miss) S. Maracineanu** and **H. Deslandres.** (Comptes Rendus, 185. pp. 122–125, July 11, 1927.)—Refers to a previous paper, dealing with the effect of polonium combined with solar radiation [see Abstract 2878 (1926)]. In addition to this, similar experiments have been made in which a tension of 120,000 volts has been applied in addition. This diminishes the effects previously observed, a negative voltage producing more diminution than a positive one. It is suggested that a new radioactive substance is formed in the mass of the lead, but it is recognised that the explanation of the phenomena requires further research. H. N. A.

HEAT.

2942. *Heat of Fusion and Specific Heat.* **K. Lichtenecker.** (Phys. Zeits. 28. pp. 473–475, July 1, 1927.)—The electric resistivity of certain metals in the liquid state is, according to Skaupy (Deutsch. Phys. Ges. Verh. 18. p. 302, 1916), twice that of the resistivity in the solid state, because in the liquid there are three degrees of freedom of the energy of translation in addition to the three degrees of freedom of the energy of oscillation. For metals with high melting points the energy content of the fused substance should be double that of the solid. In the case of ice the energy content at 0° C. is 75 calories when calculated from the specific heat; 4 calories are to be added for the work of compression, so that the total heat of fusion should be 79 calories; the experimental value is 79·25. Heated ice crystals keep their crystalline structure nearly up to the melting point. Aluminium and magnesium (metals of very high heats of fusion) break down suddenly on heating, whilst lead can be extruded (in cable sheath making) at ordinary temperature without losing its structure. In a postcript the author adds that similar considerations were already made by Skaupy in a later paper. [See Abstract 349 (1922).] H. B.

2943. *Specific Heat of the Hydrogen Molecule.* **D. M. Dennison.** (Roy. Soc., Proc. 115. pp. 483–486, July 1, 1927.)—F. Hund's recent treatment of the problem, on the basis of the wave mechanics, leads to a value of about two for β, the ratio of the weights of the symmetrical group of states to those of the antisymmetrical group [see Abstract 2222 (1927)], with $I = 1 \cdot 54 \times 10^{-41}$ gm. cm.^{2}; Hori has deduced from the far ultra-violet bands of H_2 that $I = 4 \cdot 67 \times 10^{-41}$, and β = about 1/3. The author finds that these differences are due to the fact that Hund assumed that the symmetrical and antisymmetrical terms can combine. If it is assumed that the time of transition between a symmetrical and an unsymmetrical state is very long compared with the time in which the observations of the specific heat are made, which seems likely on theoretical grounds, there are in effect two gases, and it is shown that $I = 4 \cdot 64 \times 10^{-41}$, while the antisymmetrical molecules are three times as numerous as the symmetrical ones, in agreement with Hori's values. The specific heat curve follows the observed curve to within the errors of observation. It is pointed out that the above ratio of three to one is what is to be expected on certain theoretical assumptions. H. N. A.

2944. *Thermo-Molecular Pressure in Tubes.* **M. Knudsen.** (Ann. d. Physik, 83. 6. pp. 797–821, July 20, 1927.)—The various cases of the relationship between the mean free path λ of the gas molecule and the radius r of the tube are discussed. The work of Reynolds and Maxwell is quoted, but the case is pointed out where, in comparison with λ, r is neither negligible nor very great. This is treated experimentally and theoretically, and the knowledge so obtained is applied to the measurement of low temperatures on the gas thermometer. The paper concludes with an empirical differential form of the theoretical expression, *viz.* :

$$\frac{dp}{dT} = \frac{1}{1 + 2a\frac{r}{\lambda}} \cdot \frac{p}{2T},$$

and values are worked out on this basis. The case when r is very small, but is not negligible in comparison with unity, is given by putting $a = 1$ in the above equation. If a has any other value the adsorption phenomena must also be regarded. This is fully discussed. Experimental details are given. S. G. B.

2945. *Striated Photographic Records of Explosion Waves.* **C. Campbell and D. W. Woodhead.** (Chem. Soc., J. pp. 1572–1578, July, 1927.)—An examination is made of some of the conditions required for the production of an apparently undulatory form of the explosion wave. This form appears to be characteristic of the wave in the mixture $2CO + O_2$ and in some of the more dilute mixtures of carbon monoxide and certain other gases with oxygen or oxygen and nitrogen. The presence of about 6 % of hydrogen in $2CO + O_2$, saturated with water vapour at the ordinary temperature, eliminated visible undulations. Increase in the initial pressure of the gaseous mixtures to 3 atmospheres does not effect any definite change in the distance between the undulations, but this is found to depend directly on the internal diameter of the explosion tube. The most sharply defined records are obtained when only the layers of gas near the walls of the tube are visible to the camera. The undulations visible through a window in the extreme upper portion of a tube occur alternately with those visible through the extreme lower portion. A discussion is given of possible interpretations of the phenomena. [See also Abstract 1074 (1927).] J. N. P.

2946. *Initial Stages of Gaseous Explosions. Part I. Flame Speeds during the Initial "Uniform Movement."* **W. A. Bone, R. P. Fraser, and D. A. Winter.** (Roy. Soc., Proc. 114. pp. 402–419, April 1, 1927.)—By means of two different methods, one photographic and the other electrical in character, the behaviour of undiluted mixtures of oxygen with various proportions of hydrogen, ethylene or acetylene respectively, has been investigated. With stagnant mixtures, when ignited, by means of a 2-cm. coal-gas flame, at 15° to 18° C. and atmospheric pressure at the open end of a tube 2·5 cm. diameter closed at the other end, a well-defined initial "uniform movement" is observed with all such mixtures initially propagating flame at speeds up to about 4000 cm. per sec. The speed of this uniform movement is substantially the same in successive determinations. Mixtures in which initial propagation of flame proceeds at higher velocities exhibit different behaviour. Thus, with ethylene-oxygen or acetylene-oxygen mixtures in which this occurs, no initial uniform movement is observable, the flame speed being continuously accelerated from the beginning, as though ignition had taken place near a closed, instead of an open, end of the tube. With hydrogen-oxygen mixtures a somewhat different, though equally well-marked, change takes place when the aforesaid initial speed limit is exceeded. Instead of the initial flame movement losing its uniformity, as is the case with acetylene- or ethylene-oxygen mixtures, it shows a pronounced tendency to develop quite different uniform speeds in successive experiments. This evidence engenders doubt whether it is possible to maintain rigidly either (1) that all quiescent explosive mixtures necessarily develop an initial uniform flame movement on ignition by means of a flame at the open end of a horizontal tube, or (2) that, even when a uniform movement is initially set up in such circumstances, its velocity is necessarily always the same for the same tube diameter. T. H. P.

2947. *Initial Stages of Gaseous Explosions. Part II. Examination of the Supposed Law of Flame Speeds.* **W. A. Bone, R. P. Fraser,** and **D. A. Winter.** (Roy. Soc., Proc. 114. pp. 420–441, April 1, 1927.)—Results are given of investigations made with the object of testing the validity of Payman and Wheeler's law of flame speeds, which states: Given two or more mixtures of air or oxygen with different individual gases, in each of which the speed of propagation is the same, all combinations of the mixtures of the same type, *i.e.*, all containing excess of oxygen or all containing excess of combustible gas, propagate flame at the same speeds under the same experimental conditions. The gases considered consist of mixtures of (1) $C_2H_4 + H_2 + O_2$, (2) $C_2H_2 + 2H_2 + O_2$, and (3) $CH_4 + H_2 + O_2$. In none of the series of experiments are the requirements of the supposed law fulfilled. Moreover, in all cases examined of complex ethylene-hydrogen-oxygen and methane-hydrogen-oxygen (or air) mixtures with oxygen in defect, it is found that the effect of progressively increasing the proportion of the primary hydrogen-oxygen (air) mixture in the various blendings in any particular series is to lower the observed flame speed progressively until a point is reached when the resulting complex mixture refuses to propagate flame at all. T. H. P.

2948. *Initial Stages of Gaseous Explosions. Part III. Behaviour of an Equimolecular Methane-Oxygen Mixture when Fired with Sparks of Varying Intensities.* **W. A. Bone, R. P. Fraser,** and **F. Witt.** (Roy. Soc., Proc. 114. pp. 442–449, April 1, 1927.)—Results are given of a photographic study of the behaviour of an equimolecular methane-oxygen mixture when ignited by sparks of varying intensities, (1) passed between electrodes fixed half-way along a horizontal glass tube (35 to 50 cm. long by 2 to 2·5 cm. diameter), both ends of which were closed in one experiment and both open in another, or (2) under other conditions. The photographs obtained suggest: (1) The occurrence, under ordinary sparking conditions, of what seems to be much like a definite "induction period," as a preliminary to the actual combustion; (2) an initial propagation through the medium of a ghost-like flame condition involving only a very partial combination of the gases; (3) the main combustion, following later as the result of the superposition of a compression wave or the like on a system which during the phase (2) has already become highly sensitive to chemical changes. It is not yet possible to state the proportion of the total combustion occurring during the passage through the explosive medium of the ghost-like flame, but the appearance of the photographs indicates that such proportion is relatively small. T. H. P.

2949. *Ionisation in Flames of Various Organic Substances.* **J. A. J. Bennett.** (Faraday Soc., Trans. 23. pp. 307–311, July, 1927.)—Experiments are made to determine the correlation, if any, between the degree of ionisation of various substances in flames and the amount of detonation in an engine cylinder charged with fuels containing these substances. Flames of coal-gas, hexane, ether, alcohol, acetone, etc., are studied, and the effects of the introduction of a large number of substances, including carbonyls, organic oxides, halogens and halogen compounds, organic nitrogen compounds and aldehydes, are noted. The tabulated results show that although in many cases " knock-inducers " increase, and " anti-knocks " decrease the ionisation of flames, this is not generally the case, being thus at variance with the views of Wendt and Grimms, Charch, Mack, and Boord. It is concluded that although ionisation accompanies detonation as it does all flame phenomena, there is no simple relationship between them, and that ionisation is neither a cause nor an effect of detonation, but is mainly a temperature effect. A. B. C. L.

2950. *Vapour Pressure af Acetone at Low Temperatures.* **E. H. Archibald** and **W. Ure.** (Roy. Soc. Canada, Trans. 21. Sect. 3. pp. 133–144, March, 1927.)—Measurements of the vapour pressures of acetone at temperatures between + 20° C. and − 105° C. give results in good agreement with the following modification of Nernst's formula (" Theoretical Chemistry," p. 64) : $\log_{10} P = -\frac{a}{T} + b \log_{10} T + cT + dT^2 + e$, in which P is the pressure in mm., T the absolute temperature, and a, b, c, d and e are constants, the values of which are determined from the observed data. An equation is also derived which expresses the variation of the latent heat of vaporisation of acetone with the temperature and reveals the abnormality of acetone in this respect. T. H. P.

2951. *The Use of Wave Mechanics for the Quantum Investigation of Radiation in Space.* **E. Guth.** (Zeits. f. Physik, 43. 9–10. pp. 653–657, 1927.)—The theory of radiation in space can be developed from the investigations of Lorenz and Planck by analogy with the Hamilton-Jacobi dynamics. Rubinowicz has shown that from Sommerfeld's quantum conditions, by means of the Hamilton-Jacobi differential equation, an expression can be deduced expressing the energy of vibration in a single degree of freedom of radiation in space. From this the present paper develops the Planck radiation law. The note is entirely theoretical. S. G. B.

2952. *Equation of State of a Gaseous Mixture.* **J. E. Lennard-Jones** and **W. R. Cook.** (Roy. Soc., Proc. 115. pp. 334–348, July 1, 1927.)—The paper considers the general problem of determining the forces between molecules of different kinds, by a study of the equation of state of binary mixtures. The paucity of experimental data limits the work. A theoretical formula for the equation of state of a gaseous mixture is developed and its deviation from Dalton's partial pressure law noted. In order to account for some recent experimental results on a theoretical basis it is shown that the second virial coefficient of a binary mixture is a quadratic function of the relative concentrations. A method of determining the forces between the unlike molecules of a mixture and an explanation of certain pressure characteristics are given. From Holborn and Otto's results for helium and neon it is shown that the isothermals are represented by $pv = A_p + B_p p$, and the numerical value of B_p for the mixture is in some cases greater than those of the individual gases. A table of values for B_p is given. In the case of helium the virial coefficient has a maximum value at − 140° C., whilst for neon the maximum value is at 260° C. The maximum value of B_p for a helium-neon mixture lies between these temperatures and consequently is greater for a certain range of temperature than the values for its constituents. The theoretical formula deduced for B in this paper has this characteristic, and a formula is given for the relative concentration of the gases when the maximum occurs. From the method given the concentration can be determined which would give the greatest pressure for the same total number of molecules in the gas. S. G. B.

2953. *New Equation of State for Fluids. Part I. Application to Gaseous Ethyl Ether and Carbon Dioxide.* **J. A. Beattie** and **O. C. Bridgeman.** (Am. Chem. Soc., J. 49. pp. 1665–1667, July, 1927.)—Consideration of certain thermodynamic properties of fluids leads to the following new equation of state :—

$$p = \frac{RT(1-\epsilon)}{v^2}(v+B) - \frac{A}{v^2},$$

in which $A = A_0\left(1 - \frac{a}{v}\right)$, $B = B_0\left(1 - \frac{b}{v}\right)$ and $\epsilon = \frac{c}{vT^3}$. This equation renders easy the accurate evaluation of the constants from pressure-volume-temperature data, the mathematical manipulation, including the integrability of $v.dp$ at constant temperature in terms of elementary functions, and the accurate representation of the data and their trends. It is, moreover, flexible, since more terms can be added without alteration of the general form of the expression. As it contains five constants and the gas constant, it reproduces the data on gaseous ethyl ether and carbon dioxide at least to a specific volume of 5 c.c. per gramme with an average deviation over the whole range of 0·022 and 0·030 atmosphere (0·07 and 0·08 %) respectively. T. H. P.

2954. *Equation of State of Solid Substances. Part IV. Conclusion.* **J. J. van Laar.** (K. Akad. Amsterdam, Proc. 30. 3. pp. 383–400, 1927.)—Previous papers [see Abstract 741 (1927)] dealt with different aspects of the equation of state for solid substances, and the present (final) publications deduces the pressure equations connecting the various heats of transformation of liquids and solids coexisting with their vapours, of liquids with solids, and of solid substances *inter se*. The Nernst heat theorem is only found to be valid for equilibria between two solid phases, and then only at very low temperatures. The transference of formulæ holding at these temperatures to higher temperatures (as, for example, by Nernst in the case of the two sulphur modifications at ± 100° C.) is absolutely impermissible, the formulæ being then no longer valid. H. H. Ho.

2955. *Chemical Constants and Absolute Entropy.* **W. H. Rodebush.** (Nat. Acad. Sci., Proc. 13. pp. 185–188, April, 1927.)—The entropies of sodium and potassium vapour are calculated from recent data and are compared with the values calculated from the Tetrode formula. Certain observations are made on the idea of absolute thermodynamic probability. A. Wh.

SOUND.

2956. *Constancy of Ultrasonic Velocity in Liquids with Increasing Frequency.* **R. W. Boyle and G. B. Taylor.** (Roy. Soc. Canada, Trans. 21. Sect. 3. pp. 79–83, March, 1927.)—Theoretically, no change in the velocity of sound should be expected unless the waves are so short as to become comparable with the distance of the vibrating particles or if the viscosity of the medium were extremely high. Lang has found no appreciable reduction in the velocity in brass and steel at frequencies of 50,000. Experiments on water and castor oil, using a stationary wave method, gave velocities in these liquids of $1 \cdot 48 \times 10^5$ cm./sec. at 18·5° C. and $1 \cdot 43 \times 10^5$ at 20° respectively for frequencies from 47,000 to 570,000. The velocity is therefore independent of the frequency, although it varies—*e.g.*, in sea-water—with pressure, temperature and salinity. [See Abstract 746 (1927).] G. E. A.

2957. *Passage of Acoustic Waves through Materials.* **R. W. Boyle and J. F. Lehmann.** (Roy. Soc. Canada, Trans. 21. Sect. 3. pp. 115–125, March, 1927.)—Deals with the proportion of the incident energy reflected by an infinite plate or partition of homogeneous material and finite thickness in a medium extending indefinitely in all directions when a train of *plane* sound waves is incident on one side of the plate. In some of the experiments an ultrasonic generator driven at 135,000 cycles per sec. is used and the medium is water and the plate lead. W. H. GE.

2958. *Sound Propagation in Pipes.* **H. Lichte.** (Elek. Nachrichten. 4. pp. 304–308, July, 1927.)—Theoretical and experimental study for pipes of diameter 1·5 mm. to 5 cm. and length up to 50 metres. W. H. GE.

2959. *Energy of the Struck String.* **P. Das.** (Indian Journ. of Physics, 1. pp. 437–444, June, 1927.)—Data on the subject published in the first paper of George and Beckett [see Abstract 1825 (1927)] were, in the preliminary theoretical treatment there given, shown to be consistent with the simple Kaufmann theory of the struck string. It is here shown that the data are in agreement with a rigorous solution of the equations. Four graphs for light hammers of mass 0·137, 0·29, 0·397 and 0·5 times the mass of the string are given. W. H. GE.

2960. *Wave Propagation in Strings with Continuous and Concentrated Loads.* **H. Jeffreys.** (Cambridge Phil. Soc., Proc. 23. pp. 768–778, July, 1927.)—A theoretical paper in which the motion of a light string loaded with equal masses at regular intervals is discussed by operational methods instead of by normal coordinates. It is found that the system, though possessing only a finite number of degrees of freedom, shows most of the characteristic features of dispersion. The operator $e^{-\dot{\sigma}x/c}$ that occurs in the discussion of uniform continuous strings is found to arise as the limit of an operator defined wholly in terms of definite integration, and its interpretation involves a theorem analogous to Taylor's theorem, but apparently more general. There is no phenomenon analogous to conduction of heat, but any irregularity in the distribution of mass produces strong internal reflection of the shortest waves, and may provide a mechanism for conduction. W. H. GE.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS AND ATMOSPHERIC ELECTRICITY.

2961. *Dynamics of the Electron.* **J. B. Pomey.** (Rev. Gén. d'Él. 22. pp. 183–186, July 30, 1927.)—Deals mathematically with the movement of an electron in the magnetic field about a straight filament carryint a constant current in a vacuum bulb. It is shown that the trajectory has the same form as that of a flexible, inextensible, conducting wire, which carries a current the magnetic action of which can be neglected when compared with that of an infinitely long rectilinear current in the field of which the wire is placed. The general expression for this form is worked out, and an expression is given for the length of the electron trajectory.
H. N. A.

2962. *The Exact Measurement of e/m_0 according to the Method of H. Busch.* **F. Wolf.** (Ann. d. Physik, 83. 6. pp. 849–883, July 20, 1927.)—The method employed was essentially that of Busch [see Abstract 724 (1923)], but with various improvements, which are described in detail and consist essentially of (*a*) an increase in accuracy of the voltage measurement by the use of a glow kathode tube with constant voltage source in place of an ionic tube; (*b*) the production of a magnetic field as far as possible free from disturbance; (*c*) the use of a compensation apparatus for the more exact measurement of the field current strength; and (*d*) instrument improvements. The most accurate arrangement was found to be a combination of glow kathode tube with an electrostatic rotation field. From seventy separate measurements e/m_0 was found to be $(1{\cdot}767_9 \pm 0{\cdot}0018) \times 10^7$ e.m.u.
H. H. Ho.

2963. *Transfer of Electricity from the Charged Surface of Ebonite to a Metallic Electrode.* **G. Sadakiyo.** (Electrot. Laborat. Tôkyô, Japan, Researches, No. 198 [11 pp.], May, 1927.)—Experiments were made to measure the transient changes of the potential of a rigid metal electrode placed on an ebonite plate which had been charged by rubbing with dry deerskin. The electrode was connected to one pair of quadrants of an electrometer, the other pair being earthed, while the electrode is itself surrounded by an earthed metal ring, also resting on the ebonite. Typical curves illustrate the change of potential with time after bringing the electrode and ebonite in contact. The potential of the electrode is investigated theoretically, and the theoretical curves agree with those found by experiment. The author considers that the electricity on the ebonite is not readily transferred to the electrode as soon as they are brought into contact.
R. S. R.

2964. *Currents Carried by Point Discharges beneath Thunder-Clouds and Showers.* **T. W. Wormell.** (Roy. Soc., Proc. 115. pp. 443–455, July 1, 1927.)—The current was in some of the experiments integrated by means of a special form of gas microvoltameter, which is described, while in other cases, by means of a spark gap with a small condenser and a capillary electrometer in series with one another connected across it, the integrated current was determined by counting the number of sparks, and these were recorded photographically. Schonland and Craib have recently found that in thunderstorms the clouds were of positive polarity, upper charge positive [see Abstract 2119 (1927)]. The author's observations extended over about eight months, and showed a considerable transfer of + electricity upwards from earth to atmosphere through an elevated metal point during thunderstorms and showers, *i.e.*, in the direction opposite to the fine weather ionisation current and the convection current carried by precipitation. The observations strongly suggest that the great majority of shower-clouds and thunder-clouds observed were bipolar clouds of positive polarity. H. N. A.

2965. *Theory of the Terrestrial Electric Field.* **H. Benndorf.** (Akad. Wiss. Wien, Ber. 136. 2a. No. 3–4. pp. 175–195, 1927.)—The subject is discussed under the following main headings: (1) Locality of space charges in the atmosphere; (2) the space charge at various points of the earth's surface; (3) the electric field and the vertical conduction current in the stratosphere; (4) the electric field and the conduction current at the earth's surface; (5) field and conduction current in the troposphere. More rigorous formulæ are deduced, enabling the calculation of field and conduction currents as dependent on the temporary fluctuations of conductivity and incoming current when the assumption of a stationary condition is no longer fulfilled. As constituting an advance on previous views [see Abstract 1625 (1926)], it is not now assumed that the upper layer of the atmosphere acts like a metallically conducting envelope. A closer consideration of convection currents and a further development of the theory are reserved for a future occasion. The attempt is here made to establish a quantitative relation between field, conductivity and incoming current which may be subjected to experimental proof. The treatment of the problems is entirely mathematical. E. F.

DISCHARGE AND OSCILLATIONS.

2966. *Electrodeless Discharge. Spectrum of Ionised Mercury and of Iodine.* **J. K. Robertson and J. H. Findlay.** (Roy. Soc. Canada, Trans. 21. Sect. 3. pp. 89–97, March, 1927.)—Robertson has previously shown [see Abstract 2426 (1926)] that an electrodeless discharge in hydrogen brought out ultimate arc and spark lines of certain metals placed in the discharge region. A consideration of the origin of these metallic lines suggested the desirability of examining the effect of introducing into such a discharge a small amount of the vapour of an element, the main supply of which is placed outside the discharge region. In the present paper a report is given of the results obtained, using mercury and iodine. The experimental arrangement, which is quite simple, is described. Iodine is dealt with in the pure state, in hydrogen and in helium. It is pointed out that at the end of the helium-iodine series certain parts of the inner wall of the tube are covered with a thin brownish flaky coating. When the tube is at room temperature, moreover, the iodine vapour shows no sign of the usual violet hue, but is distinctly brownish, not unlike a bromine appearance. No evidence is obtained of a possible compound of helium and iodine, the existence of which at low temperature has been shown by Boomer. A. E. G.

2967. *Current Density of the Normal Kathode Fall in the Glow Discharge.* **R. Seeliger and M. Reger.** (Ann. d. Physik, 83. 4. pp. 535–564, June 28, 1927.)—Since Hehl in the year 1901 explained the constancy of the current density at the kathode of the glow discharge with normal kathode fall, many investigations of this have been made, for here lies the key to understanding what happens in the kathode charge, especially the normal kathode fall whose theoretical explanation has not yet been attained. Holm has shortly summed up what is known of the so-called "normal current density," j_n [see Abstracts 639 and 2335 (1925)]. A further contribution to the knowledge of this subject is made in the present paper. The object of the investigation was to determine as accurately as possible the absolute value of j_n in various gases and with various kathode materials, as well as its dependence on gas pressure. The absolute value is of interest in view of a rule stated by one of the authors, which has been confirmed by measurements made by Skinner with plate kathodes, and more recently by Güntherschulze with cylinders. The connection with the pressure is of great significance for the proof of the similarity law of Holm. The rule mentioned states that with various kathodes in the same gas j_n is smaller the greater the normal kathode fall, and that with the same kathodes in various gases j_n is greater the greater the normal kathode fall is. The similarity law leads to the consequence that with plain kathodes j_n is proportional to the square of the pressure, and with cylindrical kathodes of sufficiently small diameter j_n is proportional to the first power of the pressure. The authors point out certain sources of error in previous observations, and give for the first time actual permissible values for the normal current density. Cylindrical kathodes of 3 mm. diameter were used. Three gases were used in the experiments—H, O and neon—as well as two series of binary mixtures, and the kathodes were formed of seven different metals, Al, Fe, Zn, Cu, Ag, Au, and Pt, with gas pressures from about 2 to 10 mm., thus permitting a preliminary general view of the dependence of the normal current density on kathode material, gas, and gas pressure.

The behaviour actually observed appears to be in accordance with what was previously supposed to occur. That the current density depends in a high degree on the material of the kathode and on the gas has been longest known, but not that the connection of the pressure with the current density depends also within such wide limits on these two factors. The expression $j_n = a \, . \, p^b$ is given as expressing the facts, the exponent b lying between the limits 1 and 2, and a and b are characteristic constants for each metal, and for each gas. Values of these constants are given for the gases and metals used, the current density being expressed in milliamp./cm.^{2} and the pressure in mm. Hg. The results are also exhibited in curves.

J. J. S.

2968. *Transition from Glow to Arc Discharge.* **M. Wehrli.** (Zeits. f. Physik, 44. 4–5. pp. 301–318, 1927.)—The connection between tension and current strength, tension and arc length, as well as tension and pressure, is measured with 1·7 mm. thick wolfram electrodes in pure nitrogen, both in the region of glow and arc discharge. These are proved to be especially simple, since neither chemical reaction nor melting of electrodes enter into the question. The following are the chief results obtained: The transition from normal glow to arc discharge is quite constant at pressures over 181 mm., independent of the arc length. At pressures below 104 mm. the transition is variable, the characteristic ambiguous, that is, glow or arc discharge is able to exist at the same current strength.

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At low pressures, under 20 mm., it is no longer possible to ignite the arc by increasing the current strength. Above 7 mm. the tension-arc length curves are rectilinear, that is, the Frölich equation is valid also for the glow discharge. The tension gradient calculated from it decreases at high pressures with increasing current strength, also with the transition from the glow to the arc discharge. [See also Abstract 1421 (1926).] A. E. G.

2969. *Conditions for Discontinuous Discharge in Gases.* **R. Anthouard.** (Comptes Rendus, 185. pp. 188–190, July 18, 1927.)—The phenomenon of the discontinuous passage of current between electrodes in a gas at various pressures is investigated and explained in terms of a theory based upon condenser action of the electrodes. J. S. G. T.

2970. *Geissler Discharge in Argon.* **K. G. Emeléus** and **N. L. Harris.** (Phil. Mag. 4. pp. 49–64, July, 1927.)—An experimental investigation of the Geissler discharge in argon, between cold electrodes, is described. The voltage-current characteristics of a cold collector consisting of a molybdenum wire placed at various parts of the inter-electrode space, enabled the electron concentration, the random positive ion current and the space potential at each point to be determined. The conditions of discharge corresponded to a normal kathode fall, with a gas pressure of about 1 mm. Hg, potentials of about 250 volts, and current densities of 0·1 milliampere per sq. cm. The following conclusions are drawn: (1) electron concentration and random positive ion current attain a maximum in the middle of the negative glow; (2) the current is carried from the negative glow through the Faraday dark space by slow electrons, of very approximately constant energy, moving in combined electric and diffusion fields; and (3) the electric field is reversed between the kathode dark space and the middle of the negative glow, and primary electrons are probably present. W. S. S.

2971. *Comparison of Discharges Produced by Two and Three Electrode Systems in Hydrogen.* **(Miss) B. Trevelyan.** (Phil. Mag. 4. pp. 64–77, July, 1927.)—The space potential, electron temperature and electron concentration in different parts of the discharge were derived by the method of Langmuir and Mott-Smith from the potential-current characteristics of a small collector electrode. The two-electrode tube carried a tungsten filament hot kathode, and a grid distant about 2 mm. from the kathode, the bright purple glow of the discharge striking through the grid and extending several centimetres along the tube. In the three-electrode tube the kathode and grid were as before, but a nickel anode was inserted 7 cm. from the grid. The chief difference between the discharges is that in the two-electrode system the glow is situated for the most part beyond the grid, and is practically in a region of zero resultant field. In the three-electrode system there is a field along the glow. In the former case the electron temperatures in the glow are high, and of the order of the ionisation potential of hydrogen. Indications of striation in the glow and a number of other points are discussed. W. S. S.

2972. *The Three-Point Spark Gap.* **J. D. Morgan.** (Phil. Mag. 4. pp. 91–100, July, 1927.)—An experimental investigation on the three-point spark gap which confirms C. E. Wynn-Williams' conclusion [see Abstract 1426 (1926)] that the action of the auxiliary gap is due to the ionisation of the air in the gap by the radiation from the auxiliary spark, and that the effect is due to impulsive or transient conditions. L. E. C. H.

2973. *Ionisation Tension of Helium according to the Schrödinger Theory.* **G. W. Kellner.** (Zeits. f. Physik, 44. 1. 2. pp. 91–109, 1927.)—The ionisation tension of helium is given as the difference, measured in volts, of the energy value of the normal condition of helium and the ionisation tension of simple ionised helium. According to the Schrödinger theory [see Abstract 1512 (1926)] the energy value of the normal condition is identical with the first proper value of the Schrödinger differential equation valid for helium. The Ritz method is used for the calculation of this proper value, and the first four approximations are estimated. By a simple mathematical consideration of the proper function belonging to the normal condition and a generalised physical consideration on the argument of the proper functions it is possible to arrive easily at satisfactory approximations. A. E. G.

2974. *The Ground Term of Simple Ionised Lithium according to the Schrödinger Theory.* **G. W. Kellner.** (Zeits. f. Physik, 44. 1–2. pp. 110–112, 1927.)—The ground term and with it the ionisation tension of He has been previously calculated in an approximate manner according to the Schrödinger theory [see preceding Abstract]. In the present paper the ground term of Li_+, and with it also the ionisation tension of Li_+, *i.e.*, the difference between $Li_+ - Li_{++}$, is calculated according to the same theory. A. E. G.

2975. *Electrical Conductivity of Vapours and Liquid Drops during Incipient Combustion.* **J. A. J. Bennett.** (Faraday Soc., Trans. 23. pp. 295–301, July, 1927.)—A mixture of the vapour of an organic compound and air is passed through a combustion tube fitted with gold electrodes rigidly mounted about 1 cm. apart. A constant potential difference of 30 volts is maintained between the electrodes, and the current is measured by a galvanometer. The temperature of the tube is, in each case, slowly raised to the point of inflammation or explosion. With weak mixtures no appreciable ionisation occurs below the ignition point. With rich mixtures of the less volatile substances, ionisation is pronounced above 400° C., and is accompanied by a thick fog formation. Experiments with liquid drops are similarly conducted by employing a mixture of air and spray. Measurements are made with undecane in presence of various antiknockers, nitrogen compounds and alcohols. From 300 to 500° C. the conductivity increases exponentially with the temperature. It is concluded that electrons are formed in the vapour around the liquid drops, the drops thus acquiring a high positive charge. On evaporation the liberated ions recombining with the electrons provide a considerable amount of energy to which is attributed the lowering of the ignition point of gaseous fuels when containing liquid drops. [See Abstract 1512 (1927).] J. N. P.

2976. *Reflection of Electrons from Crystal Lattices.* **F. Zwicky.** (Nat. Acad. Sci., Proc. 13. pp. 518–524, July, 1927.)—Davisson and Germer have recently published results on the reflection of electrons from a single crystal of nickel. These results have been interpreted by analogy with the reflection of X-rays from crystals. This analogy, however, is not complete. The purpose of this paper is to point out the difference between the two phenomena; one very important difference lies in the fact that the scattering of slow electrons, of the order of 100 volts, is much more intense than that of X-rays. A derivation is given for the diffraction of an electron beam by a single lattice plane. A pattern is obtained similar to that for the reflection of light by a ruled crossed grating. The resolving power for a fine lattice is calculated. Finally, it is shown that the reflecting power of a single plane is so large that it is not permissible to treat this case by analogy with X-rays. The interference pattern cannot be computed by assuming that the rays penetrate a great number of layers. On the contrary, the whole phenomenon is produced by a few layers on the surface only. The method here applied is that given by Born in a paper on periodic phenomena treated from the standpoint of wave mechanics. A. E. G.

2977. *Mobilities of Ions in Acetylene Hydrogen Mixtures.* **L. B. Loeb** and **L. du Sault.** (Nat. Acad. Sci., Proc. 13. pp. 510–516, July, 1927.)—Experiments have been made with the apparatus previously described [see Abstract 1120 (1927)] to test the conclusions arrived at by Erikson [see Abstract 197 (1927)] regarding the relative mobilities of the positive and negative ions. It is concluded that the mobilities are probably the same, and that where the negative has been found to have the higher mobility may be explained by the presence of free electrons in the early career of the ions. F. S.

2978. *Transmission of Electric Waves through the Ionised Medium.* **T. L. Eckersley.** (Phil. Mag. 4. pp. 147–165, July, 1927.)—The paper is a mathematical investigation in which it is shown that in a medium containing free electrons there is a certain critical frequency characterised by the fact that waves of lower frequency than this cannot travel through the medium. The physical reason for the existence of this frequency is shown to be connected with the fact that the electrons in the medium rob the wave of its momentum completely so that the wave can travel no further. This fact is shown to be connected with the theory of Compton scattering in which an individual quantum gives up its momentum in collision with an electron. The wave is brought to a standstill when all the quanta per unit volume are brought into collision with the electrons, which event occurs when the critical frequency is approached. F. S. B.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

2979. *Electrical and Thermal Conductivities of Carbon Steel and Cast Iron.* **H. Masumoto.** (Tôhoku Univ., Sci. Reports, 16. pp. 417–435, May, 1927. In English. Report No. 161 of the Research Inst. for Iron, Steel and other Metals.)—The electrical and thermal conductivities of Swedish carbon steels, various kinds of cast iron, K.S. magnet steel, and gold were measured by an improved form of the method due to Kohlrausch. The specimens were used in the form of rods. Expressions were obtained for calculating the specific resistance and the thermal conductivity of carbon steels from a knowledge of their composition. The electrical and thermal conductivities were measured on the specimen in the chill cast and annealed states. The annealing was carried out at different temperatures. The results of the measurement of the electrical and thermal conductivities of carbon steels and various kinds of cast iron, plotted on curves against their ratio to carbon concentration, and extrapolating to the concentration of cementite, led to the values 0·017 gm. cal./deg. cm. sec., $14 \cdot 0 \times 10^{-6}$ ohm/cm.^{3} and 0·240 for the thermal conductivity, the specific resistance, and their product for cementite. The thermal and electrical conductivities and their ratio increase considerably when graphite is formed during annealing. F. J. B.

2980. *Electrical Resistance of Molten Metals and Alloys.* **Y. Matuyama.** (Tôhoku Univ., Sci. Reports, 16. pp. 447–474, May, 1927. In English. Report No. 162 from the Research Inst. for Iron, Steel and other Metals.)—The specific electrical resistance of nine molten metals and seventeen molten binary alloys was determined. The molten metals were contained in a porcelain vessel, and the current leads were protected by suitable porcelain tubes. The column of metal between the two electrodes was measured by a microscope micrometer. The metals investigated were mercury, tin, bismuth, cadmium, lead, zinc, antimony, and silver. Seventeen binary alloys of these metals were prepared, and their specific resistance at different high temperatures was determined. The results were in agreement with those of previous investigators, but in the case of the binary alloys the results indicate that an intermetallic compound which exists in the solid phase up to the temperature of the liquidus is not decomposed by fusion, and that an intermetallic compound in the liquid phase generally dissociates in a greater degree with the rise of temperature. F. J. B.

2981. *The Hall Effect in Single Crystals of Iron.* **W. L. Webster.** (Cambridge Phil. Soc., Proc. 23. pp. 800–803, July, 1927.)—Plates were cut so that the directions of the primary current should be as close as possible to different simple crystallographic axes in the different plates. The values of the Hall coefficient obtained are the same for all the directions used within the experimental error. A strained plate gave a rather high value, which agreed with that for soft iron. The curves are very similar to those for soft iron, with a sharper bend at the saturation point; this seems to be due to the more uniform intensity of magnetisation in the single crystals. There seems to be no connection between the Hall effect and the change of resistance of the crystals in a magnetic field.

H. N. A.

2982. *Dielectric Constants.* **B. Voigt.** (Zeits. f. Physik, 44. 1–2. pp. 70–90, 1927.)—From Drude's so-called second method (Wied. Ann. 61, p. 466, 1897) an apparatus is devised for a differential method, with two condensers, for the determination of the dielectric constants of absorbing liquids. Applied in the region of higher dielectric constants to aqueous solutions of alkaline chlorides and in the region of lower dielectric constants to the determination of the temperature-coefficients of dielectric constants and of absorption-coefficients of glycerine at wave-lengths of 44·4 cm. Comparisons are given with published data. A. D.

2983. *Pressure Dependence of the Dielectric Constants of Gases and Water Vapour at Low Pressures.* **K. Wolf.** (Ann. d. Physik, 83. 6. pp. 884–902, July 20, 1927.)—Previous measurements have given a linear relationship between 1 and 350 atmospheres, but at low pressures Glaser see Abstract 1122 (1926)] has found an as yet unexplained deviation from linearity. A method is now described using oscillation discs which are so arranged as to avoid disturbances by resonance, and by which the dielectric constants of N_2, O_2, H_2, CO_2, and NH_3 are shown to possess a linear relationship with the pressure even at very low pressures. A break, however, was found in the curve for water-vapour, which, after a number of experiments, was traced to the conductivity of the insulating material of the condenser, and it was then established that the resistance even of the best insulation materials (amber, quartz, glass, etc.) very strongly decreased with increasing pressure of the unsaturated water-vapour. The paper contains some conclusions with respect to the thickness and conductivity of the adsorbed layers. H. H. Ho.

2984. *Absolute Determination of the Dielectric Constant by the Ellipsoid Method.* **R. Fürth.** (Zeits. f. Physik, 44. 4–5. pp. 256–260, 1927.)—A correction of an earlier work [see Abstract 1571 (1924)]. The author's method of determining the dielectric constant of conducting fluids is suitable for any frequency. The dielectric constant of water is determined experimentally as 78 at 50 per sec. W. V. M.

2985. *Brownian Movement of a Galvanometer Coil and the Influence of the Temperature of the Outer Circuit.* **L. S. Ornstein, H. C. Burger, J. Taylor** and **W. Clarkson.** (Roy. Soc., Proc. 115. pp. 391–406, July 1, 1927.)—The mathematical treatment is along the same lines as that of a former paper by Ornstein [see Abstract 2142 (1927)]. The Moll and Burger thermo-relay method was used to magnify the small Brownian movements of the galvanometer coil, a very high magnification factor being obtained. The methods adopted to eliminate thermoelectric effects at the junctions of the circuit, electrostatic and electromagnetic effects, disturbances due to condensation of water vapour on the leads of the coil immersed in liquid air, and the gradient of temperature along them are considered. It is also shown how errors due to tremors and seismic movements can be dealt with, and the final result shows that the influence of the temperature on a portion of the circuit agrees with that predicted by the theory, which makes it certain that the movement is entirely or mostly Brownian. H. N. A.

2986. *A Vibration-Free Capillary Electrometer.* **A. S. Gilson, Jr.,** and **G. H. Bishop.** (Optical Soc. America, J. and Rev. Sci. Inst. 15. pp. 48–52, July, 1927.)—A description of a capillary electrometer designed for physiological studies. By the use of this instrument with a thermionic amplifier small changes in potential can be recorded without the necessity of constructing an extremely sensitive capillary. The advantages of the instrument described are the use of a closed acid chamber, an upright position of the capillary, and, of even greater importance, the relatively vibration-free meniscus, which is obtained by placing the capillary midway between two balancing columns of mercury. AUTHORS.

2987. *A Valve Amplifier for Ionisation Currents.* **C. E. Wynn-Williams.** (Cambridge Phil. Soc., Proc. 23. pp. 811–828, July, 1927.)—Describes an improvement on the method which uses two resistances and two valves arranged in the arms of a bridge, with a galvanometer connected between the junction of the resistance R_1 and the valve anode A and that of R_2 and the valve anode B. The grid of A is connected to the ionisation chamber, and valve B is simply used to balance A. This arrangement has an unsteady zero, unless the two valves are identical, since the balance depends on the high-tension voltage employed and also on the voltage used to heat the kathodes. In practice the former can be kept sufficiently constant by using a battery with large cells, but the latter causes disturbances. The author has worked out the theory, and finds that if the unearthed ends of the kathode filaments are joined by a resistance wire with a sliding contact for connecting with the battery, it is possible to adjust the heating currents so that the galvanometer zero remains practically constant during an experiment. H. N. A.

ALTERNATING CURRENTS AND MAGNETISM.

2988. *Magnetic Study of Tetroxide and Trioxide of Vanadium.* **N. Perrakis.** (Comptes Rendus, 185. pp. 111–113, July 11, 1927.)—The atomic moments of tetravalent and trivalent vanadium are determined from a study of the variation of the coefficient of magnetisation of these substances with temperature. For two different ranges of temperature vanadium in the form V_2O_4 has two magnetic moments, expressed by 8 and 14 magnetons. In the form V_2O_3 its moment is 9·5 magnetons. [See Abstract 2618 (1927).] G. E. A.

2989. *The Rôle of the Satellite Electron in Paramagnetic Phenomena.* **D. M. Bose.** (Zeits. f. Physik, 43. 11–12. pp. 864–882, 1927.)—The deficiencies of the theory of paramagnetism as elaborated by Curie, Weiss, Pauli, Sommerfeld and others are set forth, and an attempt is made to explain paramagnetic phenomena by means of assumptions which do not require the adjustment of a molecule or ion in the magnetic field. It is assumed that of the two angular momenta possessed by an electron which moves in a closed orbit, designated by the quantum numbers s and l respectively, only the former is responsible for the production of paramagnetic effects. With the aid of this and other assumptions the Curie-Langevin law is derived, the magnetic moment of an ion is expressed as a function of the number of electrons in an incomplete ring, and explanations are given of Gerlach's experiments on iron and nickel and of certain magneto-mechanical experiments with ferromagnetic elements.

G. E. A.

2990. *The Measurement of Magnetic Fields and Field Changes with a Magnetron.* **M. Rössiger.** (Zeits. f. Physik, 43. 7. pp. 480–488, 1927.)—A discussion of the characteristics and construction of the Hull magnetron with a view to the construction of an instrument to register, in a manner free from inertia, rapid small changes in magnetic fields such as that of the earth. The variation of the anode current with field may be increased to 10 milliamperes/Gauss. Experiments are described to test the effects of the inclination of a magnetic field to the heated kathode, and it is shown that the magnetron records only the component of the field in the direction of this axis, and hence that, to a first approximation, small changes in the direction of a field do not affect the measurements of it. Hence a magnetron may be employed to record the total intensity of the earth's field. The second question attacked experimentally is that of producing a small tube having the required sensitivity to change in field strength. The results are not entirely satisfactory owing to difficulties in mechanical construction, but the correct method appears to have been hit upon for producing high sensitivity. W. V. M.

2991. *Certain Average Characteristics of World-Wide Magnetic Disturbances.* **S. Chapman.** (Roy. Soc., Proc. 115. pp. 242–267, July 1, 1927.)—The paper forms a sequel to the theory of magnetic storms previously published [see Abstract 89 (1919)]. An examination of published data leads to the conclusion that the average additional magnetic variations during magnetic disturbance which are superposed on the quiet-day variations do not differ much in type, as the intensity varies over a wide range. Thus, in addition to the main magnetic field of the earth and the varying field which is manifested by the diurnal magnetic variations on quiet days, there exists, from time to time, a further " disturbing " magnetic field, which has certain average characteristics in regard to space distribution and temporal changes, and that, over a wide range of variation of intensity of this field, those average characteristics do not vary greatly in type. The most natural supposition is that the field is due to a system of electric currents, part being situated in the upper atmosphere and part within the earth, the latter being secondary currents induced by the variations of the former. Current systems are proposed to explain the observed variations, and the paper concludes with a brief discussion of the origin of these currents in the light of recent data of the electrical conditions of the atmosphere. W. V. M.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

2992. *Standardisation and the X-Ray Industry.* **A. M. Codd.** (Brit. J. of Radiology, 23. pp. 221–223; Disc., 228–231, July, 1927.)—An eloquent appeal for the standardisation of X-ray accessories, fittings, etc. W. V. M.

2993. *Testing and Rating of Transformers for X-Ray Work.* **T. F. Connolly.** (Brit. J. of Radiology, 23. pp. 224–228; Disc., 228–231, July, 1927.)—Points out the absurdity of rating a transformer in kilovolt-amperes or " peak kVA," but admits its utility. The author suggests a series of tests to which commercial transformers should be subjected and which they might reasonably be expected to stand. W. V. M.

2994. *Neuromuscular Excitation by Cuneiform Waves.* **P. Fabre.** (Comptes Rendus, 184. pp. 1486–1488, June 13, 1927.)—A continuation of the work described previously [Abstract 2147 (1927)]. The chief experimental results described refer to the voltage V which must be attained in order to produce a prefatory excitation on closing the circuit with cuneiform waves of durations between 0·1 and 6 thousandths of a second. These voltages follow a hyperbolic law analogous to that enunciated by Weiss for rectangular waves. In these limits $V = \frac{0\cdot75}{t} + 2\cdot23$, where t is expressed in thousands of a second. Above seven thousandths this ceases to be valid. The experiments refer to the sciatic nerve of a frog. W. V. M.

CHEMICAL PHYSICS AND ELECTROCHEMISTRY.

2995. *Adsorption Experiments on Glasses and Filter Substances by the Method of Radioactive Indicators.* **Herta Leng.** (Akad. Wiss. Wien, Ber. 136. 2a. No. 1–2. pp. 19–42, 1927.)—Measurements are made of the adsorption of ThB, ThC, and Po. on filter papers, dialysis membranes, different types of glass, and paraffin, when alone and, in the case of ThB, when used as an indicator in admixture with lead nitrate and lead acetate. The adsorption with lead salts is found generally to agree approximately with the Langmuir relation: $a = \frac{Ac}{B + c}$, where a is the adsorbed quantity and c the equilibrium concentration of lead. Approximate agreement is also generally obtained with the Freundlich equation: $a = ac^{1/n}$. The adsorption from dilute solutions is greater with the more highly dissociated nitrate than with lead acetate indicating that the mechanism is ionic. With different types of glass large variations are obtained in the constants of the above formulæ, the value of $1/n$ in the Freundlich equation ranges from 0·012 to 0·59 according to the composition of the glass. The adsorption on glass tends to saturation at values which, for the different glasses, are found to be parallel with the potentials measured by Horovitz with these types of glass when employed as acid-alkali cells. Experiments with acids and alkali show that with positive charge of the boundary the amount of adsorbed material is diminished. The adsorption of Po. is considerably less on hard Jena glass than on a soft glass. J. N. P.

2996. *Influence of Strong Electrolytes on Solubility. Part I. The Reciprocal Influence on the Solubility of Equal Ionic Salts of Alkali Metals.* **J. Hollута** and **S. Mautner.** (Zeits. phys. Chem. 127. 5–6. pp. 455–475, 1927.)—The change of solubility of potassium chloride by the addition of sodium chloride and potassium nitrate, and of sodium chloride by the addition of potassium chloride, and of potassium nitrate by potassium chloride, was investigated in aqueous solutions at 18·5 C. The determinations were carried out up to the highest concentrations possible for the different salts. Laws which hold for non-electrolytes are applied to the results, and complete dissociation is assumed. The deviations from these laws are discussed, and a far-reaching dependence is established of the change of solubility upon the solubility and chemical nature of both the influencing and influenced salts. Equations are developed by means of which the changes in solubility at various concentrations can be calculated. The equation of V. Rothmund for calculating the reciprocal solubility changes is examined, and considerable deviations are found when complete dissociation is assumed. F. J. B.

2997. *The Soret Effect.* **A. W. Porter.** (Faraday Soc., Trans. 23. pp. 314–316, July, 1927.)—A theoretical explanation of the gradient of concentration of a solution corresponding to a gradient of temperature is advanced and an equation of equilibrium is obtained which is tested by application to the experimental results of C. C. Tanner. [See Abstract 2172 (1927).] A. B. C. L.

2998. *Law of Capillary Flow in the Case of Colloids.* **A. W. Porter** and **P. A. M. Rao**. (Faraday Soc., Trans. 23. pp. 311–314, July, 1927.)—Previous attempts so to modify Poiseuille's equation for the flow of liquids in a capillary tube that it becomes applicable to heterogeneous systems are criticised. Experimental determinations of the flow under various pressure gradients of starch sols of three concentrations are made by the capillary tube method. In interpreting the curves obtained, it is assumed that the viscosity is a function of the rate of shear, diminishing as that rate increases, and an expression is developed showing fair agreement with the experimental results. A. B. C. L.

2999. *Rigidity and Other Anomalies in Colloidal Solutions.* **E. Hatschek.** (Roy. Inst., Proc. Advance Proof [15 pp.], received July, 1927.)—Rigidity is defined as the property whereby a body resists the deformation known as "shear" and returns to its original shape on removal of the stress. Double refraction is exhibited by transparent substances when under strain. With normal liquids, such as water, rigidity is absent, the liquid yields to the smallest force, the coefficient of viscosity is independent of the rate of shear, and no double refraction can be produced by stirring rapidly. Many colloidal solutions are found, however, to behave in an anomalous manner; their viscosity cannot be measured accurately by the capillary viscometer, and when measured by the method of a rotating disc or concentric cylinders, as in the Couette viscometer, the results vary largely with the rate of shear. A solution containing 0·25 % of ammonium oleate, also dilute solutions of benzopurpurin, cotton yellow, and mercury sulpho-salicylic acid exhibit this anomaly to a high degree and possess a very pronounced rigidity at low rates of shear. The viscosities become infinitely high for infinitely small velocity gradients. Double refraction is also exhibited by these liquids on deformation. In all cases these solutions lose their rigidity at about the same temperature, *viz.*, 40° C. These variable viscosity phenomena are produced in normal liquids by suspending microscopic particles of nearly spherical shape. [See also Abstract 2167 (1927).] J. N. P.

3000. *Influence of Boundary Films on Corrosive Action.* **L. H. Callendar.** (Roy. Soc., Proc. 115. pp. 349–372, July 1, 1927.)—The local corrosion of metals in normal waters is found to be determined by boundary films of a solid, liquid, or gaseous nature present on the metal surface. The surface of those metals liable to local corrosion is normally more or less covered with an oxide film, and where this film is of higher potential than the metal itself, its distribution determines the location of the primary kathode and anode areas before the metal comes in contact with the electrolyte. The distribution of this oxide film is determined by the presence of foreign substances on the metal surface and by irregularities in the surface itself. When the metal comes in contact with the electrolyte the oxide film is the primary kathode, and metal passes into solution at unoxidised parts of the surface. The thicker oxide films formed by heating give a high boundary resistance, and must tend to retard corrosive action; oxidising electrolytes also retard corrosion by increasing boundary resistance. With aluminium the boundary resistance increases both with

increasing dilution of the electrolyte and with increasing thickness of any oxide film present on the metal surface. [See also Abstract 3075 (1924).]
J. N. P.

3001. *The Rusting of Steel Surfaces in Contact.* **G. A. Tomlinson.** (Roy. Soc., Proc. 115. pp. 472–483, July 1, 1927.)—The experiments show that with clean polished surfaces no oxidation occurs when they are brought in contact unless there is a relative tangential motion of the surfaces, even with very great normal stress. It is probable that the discolouration produced is a result of molecular cohesion, and that molecules can be detached by a lateral movement, but not by a normal movement or by pure rolling of one surface on the other. The molecules detached are rapidly oxidised. Experimental evidence has been obtained that there is a certain magnitude of relative motion, $6 \cdot 5 \times 10^{-8}$ in., below which the molecules may be disturbed and yet return to their original configuration. The value of the radius of molecular attraction arrived at by Johonott and by Chamberlain is 8×10^{-8} in. The effect of a film of grease or oil was investigated, and other possible causes of the rusting were considered.
H. N. A.

3002. *Electron Affinity of Some Stable Molecules at High Temperatures.* **G. Piccardi.** (Zeits. f. Physik, 43. 11–12. pp. 899–920, 1927.)—When two pieces of platinum are held in the tip of a Bunsen flame and a pearl of some salt is introduced into the flame, the ions and electrons of the metal collect on the electrodes, and the weak flame current increases owing to the ionisation $A \rightleftarrows A_{+} + e$. At the high temperatures the influence of the acid radicle can be neglected. When the ions are negative, the flame current should be reversed, not merely diminished. These determinations of ionisation potentials U do not require any knowledge of the flame temperature. For work at higher temperatures on stable molecules the temperature T should be known in order to apply the formula $\log K = 23052U/4 \cdot 571T$. But the U of iodine being known also from experiments by other methods (3·58 volts), the electron affinity of SO_2, *e.g.*, can be deduced from the equation $\log K_I/\log K_{SO_2} = U_I/U_{SO_2}$. The determinations are exceedingly difficult, and require absolutely pure flames. Experiments have been made on Cl_2, P_2O_5, WO_3 and other acid oxides. Particulars are given for SO_2 (introduced into the flame either as H_2S or as SO_2), affinity potential 2·8, and SeO_2 (introduced after passing through a furnace), potential 2·3 volts. [See Abstracts 152 and 2223 (1926).]
H. B.

3003. *Proof of the Relative Velocity of the Decomposition Products during Optical Dissociation Processes.* **T. R. Hogness** and **J. Franck.** (Zeits. f. Physik, 44. 1–2. pp. 26–31, 1927.)—During the photochemical dissociation of a molecule, the quantity $h\nu - D$ must be transferred into translation energy of the separating part of the molecule, where ν is the frequency of the incident light and D the work spent on the act of dissociation. This result has been confirmed experimentally for the photochemical decomposition of sodium iodide into an iodine atom and an excited sodium atom by means of Doppler effect observations.
H. H. Ho.

3004. *Catalyst Poisons.* **F. H. Constable.** (Cambridge Phil. Soc., Proc. 23. pp. 832–837, July, 1927.)—In the poisoning of the hydrogenation of ethylene (the catalyst being copper) by increasing quantities of carbonic oxide, the mean life of the carbon monoxide molecule is very much greater on the centres which are most active in hydrogenation than on the rest of the surface. This brings forward additional evidence in favour of the enhanced fields on the most active spots on the surface. The variation of the activity of the individual centres with increasing doses of the catalyst poison in the case of uni- and bi-molecular reactions is worked out. A. D.

3005. *The Nature of Sintering of Active Copper Catalysts.* **F. H. Constable.** (Chem. Soc., J. pp. 1578–1584, July, 1927.)—The course of the oxidation of films of metal supported on a china-clay rod is measured by determining the electrical conductivity of the metal-oxide mixture and by estimating the thickness of the surface film of oxide by means of its colour in normally reflected light. In the relation derived by Dunn, $W^2 = Kt$, where W is the weight of oxide formed in time t, measurements are made of the influence on K produced by active and sintered catalysts. The nature of the departure from the parabolic law is studied when films of copper are rendered active by alternate oxidation and reduction at 210° C., when oxidation is arrested, and when activated films prepared at 210° C. are sintered at 440° C. for different periods, and the rate of oxidation measured after each sintering. Comparative measurements are made of the fall in catalytic activity in the dehydrogenation of alcohol with decrease in surface area. It is estimated that the reduction in the surface is somewhat more effective in reducing catalytic activity than is the collapse in the actual centres existing on the surface. The results indicate that the energy present in the centres of activity is not very greatly in excess of that possessed by the regular arrangement of the surface atoms. The results accord better with the hypothesis of Pease and Constable rather than that of Armstrong and Hilditch, who attribute to the centres of activity in catalysts a quantity of energy that approaches the heat of vaporisation of the metallic atoms. J. N. P.

3006. *Decomposition of Nitrous Oxide in the Silent Electric Discharge.* **S. S. Joshi.** (Faraday Soc., Trans. 23. pp. 227–238, May, 1927.)—Nitrous oxide subjected to the silent discharge produced by the application of 6000–12,400 volts to the electrodes of a Siemens ozoniser is decomposed to nitrogen and oxygen. The lower the initial pressure of nitrous oxide, the more rapid is the decomposition. With a tension of 12,400 volts and initial N_2O pressure of 42·0 cm. the percentage decomposition at the end of one hour is 96, whilst with 82·4 cm. pressure, the decomposition after one hour falls to 2·3 %. The rate of decomposition increases with increase of voltage. In the initial stages of the reaction NO_2 is formed as an intermediate product, and the reaction is complicated by the fact that some oxygen is converted to ozone. This then combines with nitrogen peroxide to form nitrogen pentoxide. It is considered probable that the initial stages of the decomposition are two simultaneous reactions, (1) followed by (2) :—

$$(1)\ \begin{cases} 2N_2O \rightarrow 2N_2 + O_2 \\ 2N_2O \rightarrow 2NO + N_2. \end{cases}$$

$$(2)\ 2NO + O_2 \rightarrow 2NO_2.$$

It is found that the current passing through the reaction vessel varies with the stages of the decomposition of the nitrous oxide. L. M. C.

3007. *Decomposition of Some Organic Substances by the Electric Spark.* **N. R. Fowler** and **E. W. J. Mardles.** (Faraday Soc., Trans. 23. pp. 301–306, July, 1927.)—Sparks of ½ to 1 cm. from an induction coil with a Wehnelt electrolytic interrupter are passed between carbon rods mounted in the side walls of a glass flask filled with various organic liquids. Paraffins are thus broken down into the elements, stable gases, and free radicles such as $\equiv CH$, $=CH_2$, or $-CH_3$, which can only exist momentarily and polymerise or conjugate to form acetylene, etc. The greater the disruptive force the higher is the yield of the free element. With the aromatic compounds the formation of free radicles such as C_6H_5-, C_6H_5NH-, $C_6H_5N=$, etc., result in the formation of complex substances of high molecular weight or tars by their interaction or conjugation. The amount of tar formation is greater with aniline and monomethyl aniline than with dimethyl aniline, while the amount of gaseous products is lower. This may be explained by the ability of the primary and secondary amines to form free radicles by the direct removal of hydrogen attached to the nitrogen molecule. The primary and secondary amines have been found to delay detonation in the internal combustion engine, whilst tertiary amines have practically no effect. The behaviour appears to be due to the autoxidation of the $-NH_2$ and $=NH$ group by organic peroxides formed during slow combustion, the radicle $RN=$ polymerising to form tars.

J. N. P.

3008. *Theories of Unimolecular Gas Reactions at Low Pressures.* **O. K. Rice** and **H. C. Ramsperger.** (Am. Chem. Soc., J. 49. pp. 1617–1692, July, 1927.)—A collision theory of honogeneous gas-phase, unimolecular reactions at low pressures is developed to account for an observed falling off in rates of reaction at low pressures. Account is taken of the distribution of energy among the large number of degrees of freedom of the rather complex molecules that are known to decompose in unimolecular manner, and the extent to which the reaction rate is influenced by the initial pressure is tested experimentally. All molecules which have a certain minimum total energy which can be calculated from the temperature coefficient are said to be activated. According to one theory a calculation is made of the rate of activation by assuming that each collision of an activated molecule results in deactivation. An equation which is derived is of the form: $K = K_{\infty} p(p + \beta_1)$, where K is the rate constant, K_{∞} the rate constant at high pressure, p the pressure, and β_1 a constant. According to an alternative theory, an equation is derived to determine the relative reaction rate at various pressures on the assumption that the activated molecule reacts only if it contains a certain minimum of energy in a particular degree of freedom, and that if the molecule has a large excess of energy beyond that required for activation the probability is increased of the energy entering a particular degree of freedom to ensure reaction. Data on the decomposition of propionic aldehyde agree about equally well with the values calculated by either of the theories. [See also Abstract 823 (1927).]

J. N. P.

3009. *Activity Coefficient of Hydrogen Chloride in Aqueous Solutions with Barium and Lanthanum Chlorides.* **M. Randall** and **G. F. Breckenridge.** (Am. Chem. Soc., J. 49. pp. 1435–1445, June, 1927.)—Measurements are made at 25° C. of the e.m.f. of the hydrogen-calomel cell, with hydrochloric acid and with mixtures of hydrogen and barium chlorides and hydrogen and lanthanum chlorides respectively. The concentration of both chlorides in each series is varied over wide limits. An approximately linear relation is obtained by plotting $(\log \gamma)/\mu^{\frac{1}{2}}$ against $\mu^{\frac{1}{2}}$, where γ is the activity coefficient and μ the ionic strength. The data supports the principle of Lewis and Randall, which states that the activity coefficient depends more particularly on the ionic strength. The results are in accordance with an equation of the type: $(\log \gamma)/\mu^{\frac{1}{2}} = A + B\mu^{\frac{1}{2}} + \ldots$

As the percentage of barium or lanthanum chloride is increased, the value of B becomes somewhat smaller, and the minima in the activity coefficients are displaced in the direction of higher concentration. The logarithm of the activity coefficient of the hydrochloric acid in mixtures of constant ionic strength is shown to be a nearly linear function of the ratio of the mean molality of the acid to the molality of pure acid at the same ionic strength. J. N. P.

3010. *Activity Coefficient of Sulphuric Acid in Aqueous Solutions with Sodium Sulphate.* **M. Randall** and **C. T. Langford.** (Am. Chem. Soc., J. 49. pp. 1445–1450, June, 1927.)—Potential measurements are made with the hydrogen-mercurous sulphate cell in which the electrolyte consists of sulphuric acid and sodium sulphate. In different series the molality of the sulphate ion is maintained constant at 0·2, 0·5, 1·0 and 2·0 m. respectively, while the molal ratio of sulphuric acid to sodium sulphate is varied. Graphs are given in which $\log \gamma$ and $(\log \gamma)\mu^{\frac{1}{2}}$ are plotted against $\mu^{\frac{1}{2}}$. By plotting $\log \gamma$ against the ratios of the average molality of the sulphuric acid to the average molality of sulphuric acid in a solution of pure sulphuric acid of the same ionic strength as that of the mixture, the curves approximate to horizontal straight lines at the higher dilutions in accordance with the ionic strength principle. J. N. P.

3011. *Electroendosmosis of Aqueous Solutions through a Diaphragm of Sintered Glass Powder.* **F. Fairbrother** and **H. Varley.** (Chem. Soc., J. pp. 1584–1589, July, 1927.)—Electroendosmosis experiments are carried out with a diaphragm of sintered Jena "Geräte" glass powder in water and in hydrochloric acid solutions of varying concentration. The amount of electroendosmosis decreases after a time, and in 0·01 N. HCl it becomes reversed in direction. Measurements on the permeability of the diaphragm to water show that this also decreases with the time during which water is passed through the diaphragm. It is suggested that these results indicate that the glass surface undergoes a swelling process, and, further, that the distribution of potential within the swollen layer may account for the reversal of direction. This view is in accordance with the conclusions of Haber and Klemensiewicz, who postulate the existence of a swollen layer on the surface of the glass in explaining their observations with the glass electrode. J. N. P.

3012. *Calculation of the Equivalent Conductivity of Strong Electrolytes.* **A. Ferguson** and **I. Vogel.** (Phil. Mag. 4. pp. 233–242, July, 1927.)—The calculation of the equivalent conductivity of strong electrolytes has been by means of an equation of the general form $\Lambda_0 = \Lambda + F(\Lambda, C)$. The authors employed the equation $\Lambda_0 = \Lambda + BC^n$, and they have shown that the values for n and B cannot be taken as constant, but that they change from electrolyte to electrolyte. They also point out that the results computed with the values for n and B, characteristic for each electrolyte, were more likely to be reliable than those calculated from other equations. The method is now applied to the experimental data at 0°, 18° and 25° C. for a large number of salts, and very consistent results are obtained. F. J. B.

3013. *Calculation of Activity Coefficients from Conductivity Measurements.* **C. W. Davies.** (Phil. Mag. 4. pp. 244–250, July, 1927.)—The activity coefficients for a number of acids are calculated from existing data. The most reliable series of measurements give the following values for the activity coefficients: formic acid, 0·382; acetic acid, 0·393; cyanoacetic acid, 0·372; and the most probable value for the acids investigated is $A = 0{\cdot}38 \pm 0{\cdot}01$. This is in agreement with previous measurements, 0·393 from freezing point determinations, and 0·39 from measurements of the e.m.f., and is generally in agreement with the value 0·37 required by the Milner theory. F. J. B.

3014. *Conductivity of Hydrofluoric Acid.* **M. Auméras.** (Comptes Rendus, 184. pp. 1050–1052, June 27, 1927.)—From a purely chemical method the author obtained a dissociation constant at 25° C. for $\overset{+}{H} + \overset{-}{F} \rightleftarrows HF$ of $16{\cdot}7 \times 10^{-5}$ per litre. H. Pick, by the use of the electrical conductivity measured by Ostwald, obtained the value $7{\cdot}2 \times 10^{-4}$. The author, suspecting the difference to be due to small amounts of hydrofluosilicic acid present as an impurity, took particular care to avoid all impurities and measured the constant for various concentrations of HF. The Kohlrausch method was used, and the results are shown in a graph and compared with Pick's results. There is an increasing divergence at lower concentrations, and the value must be lower than Pick's. The author confirms his earlier figure. R. S. R.

3015. *Electrochemistry of Solutions of Aluminium Bromide in Nitrobenzene.* **W. A. Plotnikow and M. A. Bendetzky.** (Zeits. phys. Chem. 127. 3–4. pp. 225–232, July, 1927.)—Measurements of the specific and molecular conductivity of solutions of aluminium bromide in nitrobenzene at concentrations of from 0·27 % to 58·6 % and temperatures of from 0° C. to 80° C. are made by means of a Wheatstone bridge. The curves giving the relation between specific electrical conductivity and concentration have a maximum at all temperatures. For a solution of 28·3 % at 50° C. $X = 252 \,.\, 10^{-5}$. The specific conductivity at first increases with the temperature, reaches a maximum, and then decreases with further increase of temperature. The temperature coefficient of electrical conductivity increases with the concentration. During electrolysis bromine separates at the anode in amounts agreeing approximately with its electrochemical equivalent. At the kathode the liquid becomes opaque and ammonia is formed. [See also Abstract 652 (1926).] J. N. P.

3016. *The Becquerel Effect with Copper Oxide Electrodes.* **W. J. D. van Dyck.** (Zeits. phys. Chem. 127. 3–4. pp. 249–301, July, 1927.)—By the Becquerel effect is meant the observed phenomenon that certain substances when placed as electrodes in suitable electrolytes exhibit towards these electrolytes a potential difference which depends upon the incident light. The study of this effect is important as not only likely to throw light on the mechanism of photochemical effects, but also because electrical methods of measurement are the most accurate and enable quickly proceeding processes to be followed and an insight to be obtained into the primary process. The author first had the intention of examining the Becquerel effect in the case of the silver halogens, but the relations of these substances are so complicated that a simpler case was chosen, that of copper oxide. In this substance the effect is very powerful, and it possesses other advantages. The investigation links itself to those of Goldmann, Brodsky and Samsonow, which already make it probable that copper oxide acts only as an oxygen electrode, and the oxygen concentration at the electrode is decisive. The first part of the paper gives a full description of the experiments carried out, and is illustrated by diagrams of the apparatus and by curves expressing the results of the experiments. Goldmann and Brodsky's methods of measurement were modified so as to give a quicker determination of the photo-effect. The sensitive electrode was improved in which pure CuO or mixed CuO and Cu_2O were spread in well-defined layers on platinum. The dependence of the photoelectric characteristic on wave-length was investigated, and it is shown that the Becquerel effect of CuO is not merely a simpler case of the Hallwachs effect. It was found that the photo-effect of CuO and Cu_2O are opposed to each other, and the photoelectric sensitiveness of both effects per unit of incident radiation energy was measured. Investigation was made of the light absorption of CuO, and a thermopile is described by means of which the quantum yield of the Becquerel effect was determined. As regards photochemical phenomena, it appears that without an electric current no marked decomposition of the light takes place. The curves of rise of the photo-effect of CuO and Cu_2O were measured and the influence of the electric resistance traced. The capacity of the surface layer was measured and its influence on the curve of rise is discussed. Various possible explanations of the effect are considered. The peculiarities of the crystal structure appear to play an important part in the phenomenon. From thermodynamical considerations a potential is determined beyond which no CuO effect is to be expected. Various anomalies in the photoelectric characteristic are treated theoretically. J. J. S.

3017. *Coefficients of Ionic Distribution. Part I.* **N. Bjerrum** and **E. Larsson.** (Zeits. phys. Chem. 127. 5–6. pp. 358–384, July, 1927.)—Results are given of measurements of the coefficients of distribution of 23 ions between water and ethyl alcohol, the values being given of $P = \log_{10} V$, where V is the coefficient of distribution and P is known as the distribution exponent. This exponent is composed of an electric member P_e dependent on the ionic charge ($z\epsilon$), of a second member P_u dependent on other molecular forces, and of a third member P_s dependent on the different degrees of solvation in the two solvents, $P = P_e + P_u + P_s$.

The electric member is given by the expression

$$P_e = \frac{z^2\epsilon^2}{2rkT}\left(\frac{1}{D_A} - \frac{1}{D_{H_2O}}\right) \log e,$$

where r is the ionic radius, D_A and D_{H_2O} the dielectric constants of alcohol and water respectively; for the term P_u the distribution exponents of a similar but neutral molecule and for the solvation member

P_4 the logarithm to base 10 of the constant of the solvation equilibrium in mixed solvents may be substituted. These considerations are used to make a preliminary comparison of the calculated with the experimental results. The significance of the distribution coefficients of the ions for phase boundary potentials, for Soret's phenomenon, and for thermoelectric forces in solutions of electrolytes is discussed. T. H. P.

3018. *Moving-Boundary Method for Determining Transference Numbers. Part VI. Further Developments in Experimental Technique.* **D. A. MacInnes, I. A. Cowperthwaite** and **T. C. Huang.** (Am. Chem. Soc., J. 49. pp. 1710–1717, July, 1927.)—Modifications in moving-boundary apparatus for determining transference numbers are described which render its operation more convenient and its results more accurate. The measurements are greatly influenced by vibration, especially when much difference exists between the densities of the solutions at the boundary; this difficulty may be overcome by the use of a modified Julius suspension for the thermostat. The experimental results obtained indicate that boundaries must be descending during the determinations, since ascending boundaries give rise to heat effects which cause mixing. The conditions governing the visibility of boundaries, and certain of the factories governing "adjustment"—that is, the dependence of the motion of the boundary on the indicator concentration—are outlined. The precision of the method is shown by measurements of the transference number of 0·05 N silver nitrate solution. T. H. P.

3019. *A New Method for Preparing Boron.* **L. Andrieux.** (Comptes Rendus, 185. pp. 119–120, July 11, 1927.)—When a mixture corresponding to the formulæ $2B_2O_3 + MO + MF_2$, where M is a metal, is fused and electrolysed, it is found that in some cases the metal M is deposited on the kathode, in others a boride of the metal mixed with more or less boron. In the second case the metal M produced by the primary reaction reduces the B_2O_3. The author has investigated the behaviour of a number of different metals, and finds that when magnesium oxide and fluoride are employed, and the fused mixture is electrolysed at 1100° C., up to 92 % of boron is contained in the deposit on the kathode, after this has been powdered and treated with HCl. The amount corresponds to 95 % of the theoretical quantity for the number of coulombs employed.

H. N. A.